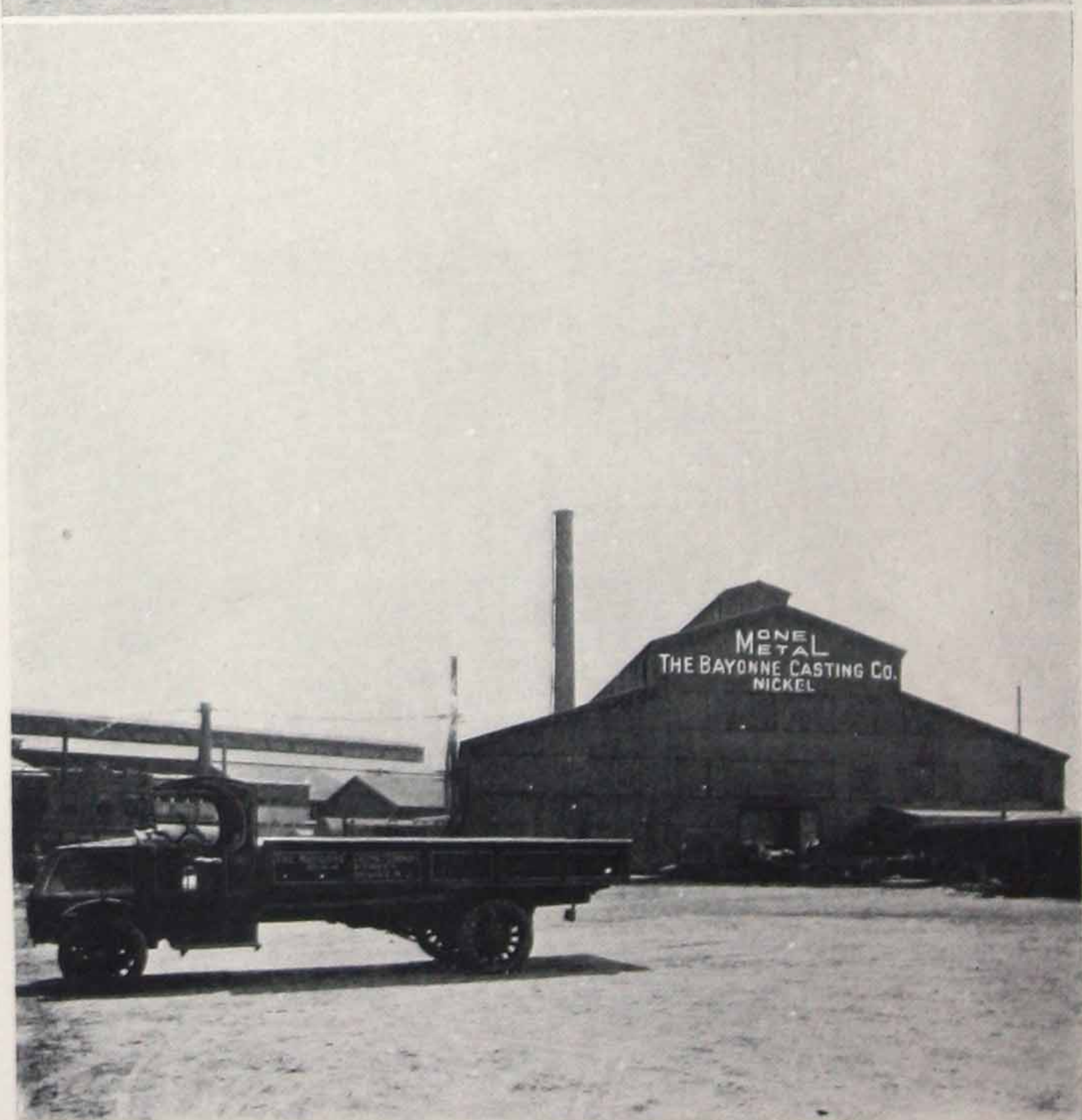
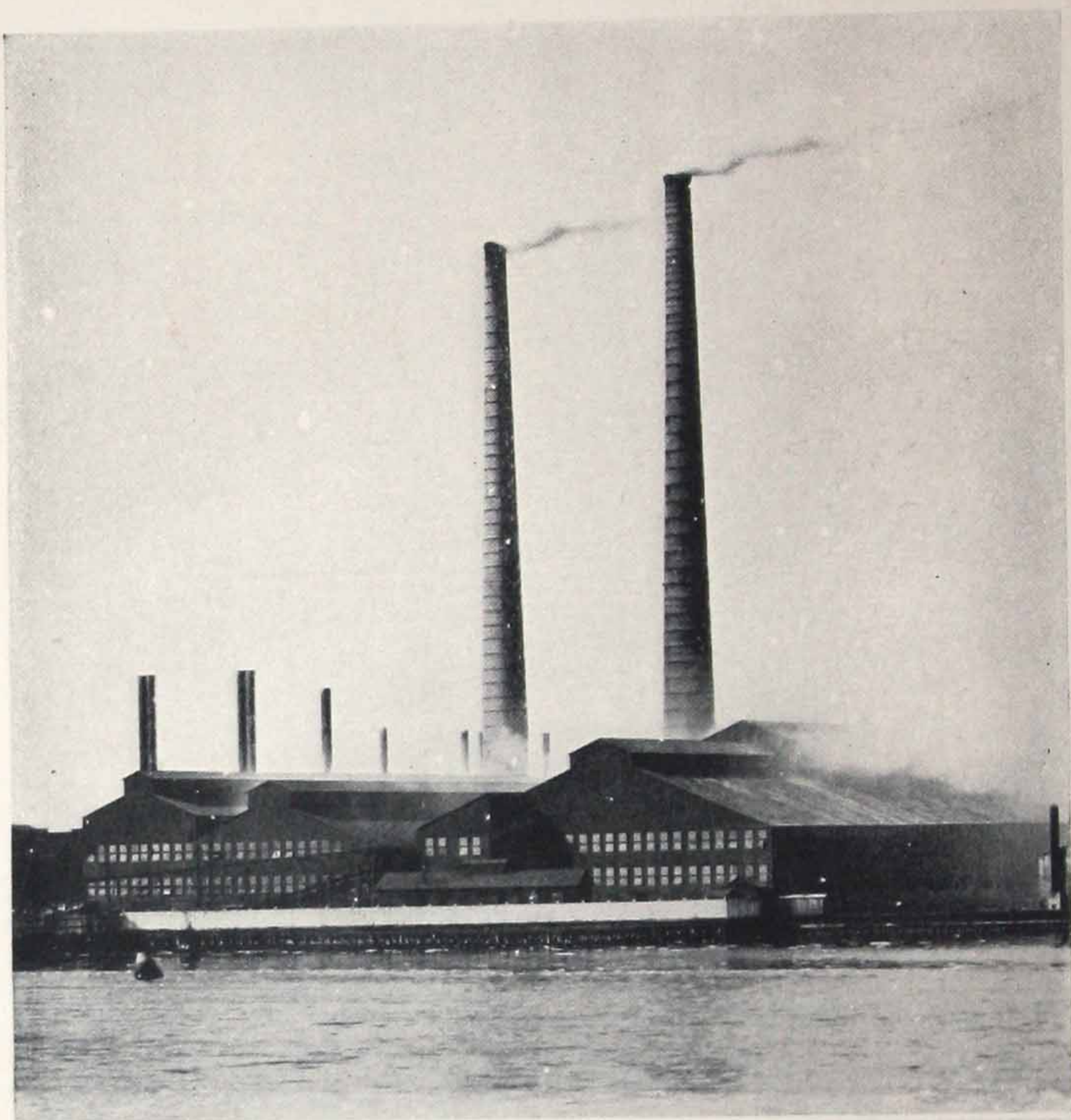


069.733

MONEI METAL

THE BAYONNE CASTING COMPANY
BAYONNE N.J.



Plant of The International Nickel Company, Bayonne,
New Jersey, Where Monel Metal is Refined

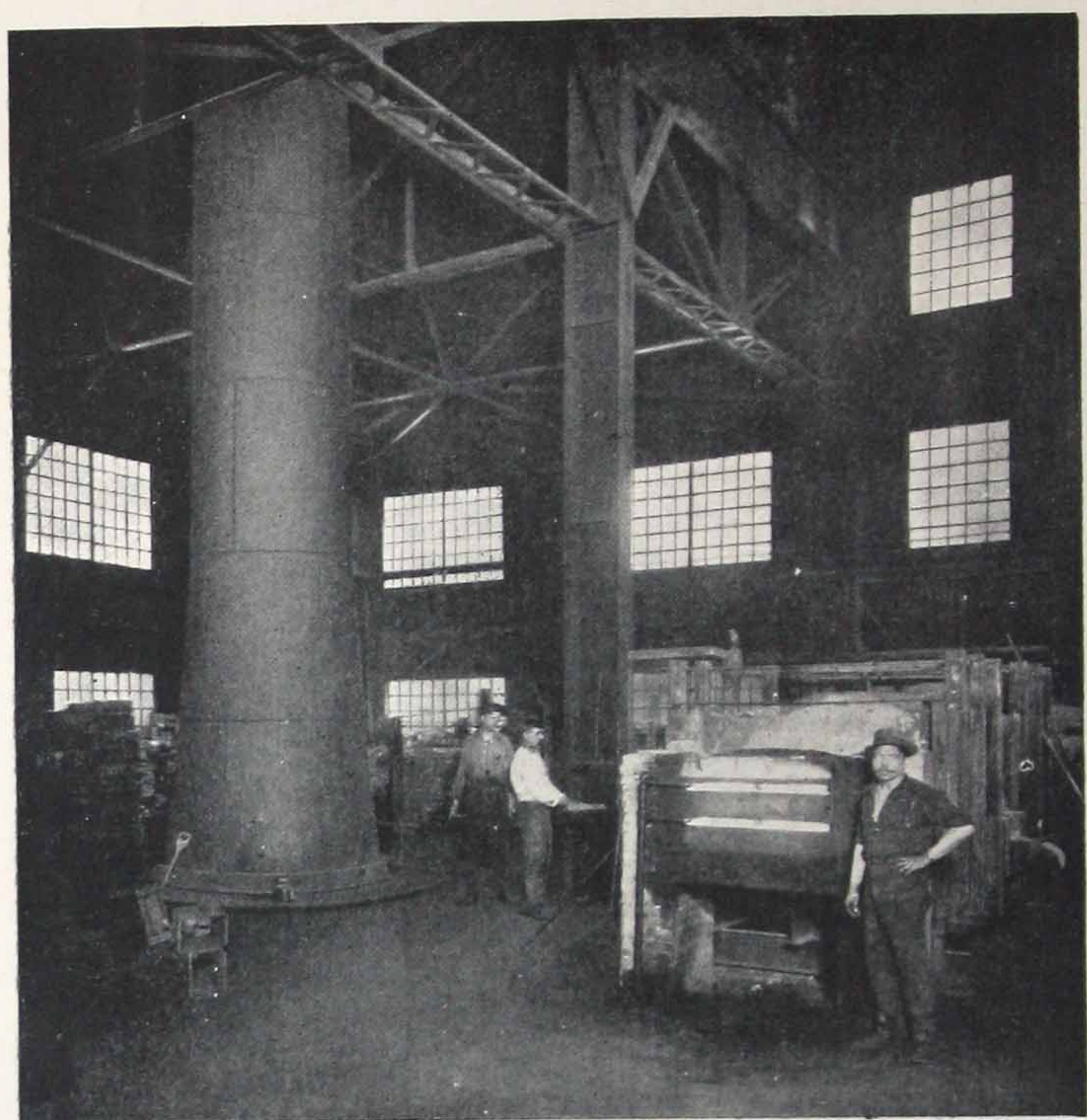
Plant of The Bayonne Casting Co., Bayonne, New Jersey
Where Monel Metal Castings are Made

MONEL METAL

**NON-CORRODIBLE
STRONG AS STEEL**

THE BAYONNE CASTING CO.
BAYONNE, NEW JERSEY

MONEL METAL



Views of Foundry, Bayonne Casting Co.

THE BAYONNE CASTING CO.

MONEL METAL

Introductory

IT is truly said that industry never creates a demand that the engineer or metallurgist does not meet.

Copper and bronze alloys served most purposes satisfactorily so long as they were only required to withstand alkaline or acid solutions. With the growth of industry new conditions have arisen which call for metals possessing unusual qualities. There is a broad field for an alloy which will withstand acids, high temperatures and the erosive action of hot gases and superheated steam. Monel Metal, highly non-corrodible and with the strength of steel, meets these severe requirements. Monel Metal was first made ten years ago, and the demand for it has grown as rapidly as the knowledge of its characteristics could be spread.

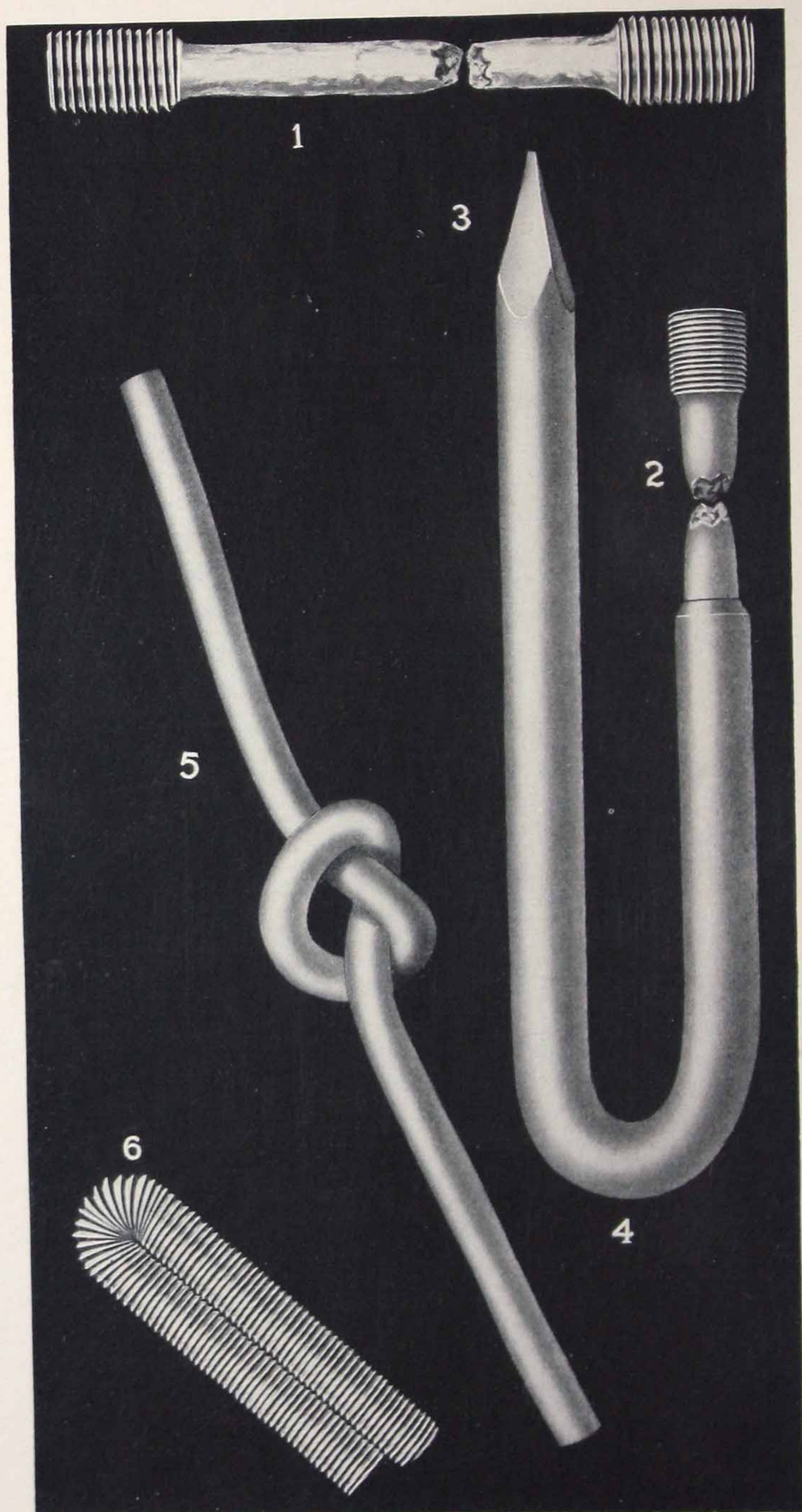
In the early stages of development, Monel Metal was supplied only for its high tensile strength and relative immunity to corrosion, while at the present time Monel Metal has many diversified uses.

It is the endeavor of The Bayonne Casting Company in issuing this pamphlet to direct attention to the physical properties of Monel Metal, the forms in which it is sold and its general uses. It is our further purpose to co-operate in every way with the users of Monel Metal in order to insure its satisfactory application and service. Some of the methods of treatment are not very generally understood and it is our desire that any consumer wishing technical advice or information will communicate with us.

The Bayonne Casting Company

THE BAYONNE CASTING CO.

MONEL METAL



Test Pieces Monel Metal

No. 1
Test Piece, Cast Monel Metal
Elastic Limit.....35,150 lbs.
Breaking Strength..75,900 lbs.
Elongation in 2".....40%
No. 3.—Hot Point 1¼" Rod
No. 5.—¾" Rod Knotted Cold

No. 2
Test Piece, Monel Metal Rod
Elastic Limit.....69,600 lbs.
Breaking Strength..98,000 lbs.
Elongation in 2".....45%
No. 4.—Cold Bend 1¼" Rod
No. 6.—1" Rod Threaded and
bent cold on itself without
fracture

THE BAYONNE CASTING CO.

MONEL METAL

Physical Characteristics

MONEL METAL is not a synthetic alloy, but is a natural combination of nickel and copper which is refined without changing the relation of the important elements, *i. e.* Nickel and Copper. These important elements bear the same relation to each other when the alloy is refined and fabricated as when taken from the mines. The smelting and refining merely remove the undesirable elements. Monel Metal contains approximately 67% Nickel, 28% Copper, and 5% other metals.

The ore is mined and smelted in Ontario by The International Nickel Company, who are the sole producers and refiners of Monel Metal. The metal in the form of matte is shipped to the Orford Works of The International Nickel Company, at Bayonne, New Jersey, where it is refined and distributed for fabrication in the form of rods, castings, forgings, tubes, wire, strip stock, sheets, etc. Some idea of the varied uses for which Monel Metal has proved superior may be obtained by referring to pages 44 and 45. In nearly every instance where Monel Metal has been adopted it has replaced some other metal that would not meet the requirements.

Monel Metal can hardly be distinguished from pure Nickel in color; in tensile properties it closely resembles steel, as can be seen by referring to the table of physical properties and tensile tests on pages 8 and 9; it is tough and ductile and can be machined, forged, soldered, brazed and welded by the electric or oxy-acetylene method.

It lends itself admirably to casting and many very intricate patterns have been cast successfully. In its cast form it has the great advantage of unusually high tensile strength. In rod form its tensile strength is also high, and it may be worked with equal facility either hot or cold.

In addition to its resistance to corrosive conditions, Monel Metal also resists oxidation, due to its high nickel content, since nickel possesses in a high degree the property of withstanding the oxidizing influence of hot gases.

THE BAYONNE CASTING CO.

MONEL METAL

Table of Physical Properties

Melting Point.....	1,360° C. (2,480° F.)
Specific Gravity (Cast).....	8.87
Weight Per Cu. In. (Cast).....	0.319 lbs.
Weight Per Cu. In. (Rolled).....	0.323 lbs.
Coefficient of expansion, (20° C.—100° C.).....	0.00001375 per 1° C.
Electrical Resistivity, 256 Ohms per mil-foot. (Temp. Coefficient).....	0.0011 per 1° F.
Electrical Conductivity.....	4% (Copper 100%)
Heat Conductivity.....	1/15 that of Copper
Shrinkage.....	1/4" per foot
Hardness Cast Material.....	20-23 (Shore Scleroscope)
Hardness Hot Rolled Rods 27 (Average Shore Scleroscope)	
Hardness, Hot Rolled Rods.....	162 (Average Brinnell)
Modulus of Elasticity.....	22,000,000-23,000,000

Tests on Rods

Tensile

Averages of last fifty tests of each of the three divisions as given:

	Yield Point Lbs. per Sq. In.	Ultimate Tensile Strength Lbs. Per Sq. In.	Per Cent Elongation in 2"
Up to 1 inch.....	63,126	94,562	40%
1 1/16 inches to and including 1 11/16 inches.....	61,963	93,104	39%
1 3/4 inches to and including 2 7/16 inches.....	50,115	87,678	42%
2 1/2 inches to and including 3 1/2 inches.....	43,805	85,282	44%
Over 3 1/2 inches.....	47,335	84,763	43%
Rectangles.....	56,353	85,562	42%
Hexagons.....	60,736	87,781	40%

Torsional (Average)

Shearing stress—Lbs. per sq. in. on remotest fibres:

At Elastic Limit.....31,796

At Ultimate Load.....79,053

Compression

Elastic Limit.....25,500 to 32,000 lbs. per sq. in.

THE BAYONNE CASTING CO.

MONEL METAL

Tests on Castings

Tensile

(Average of 172 Heats tested for Isthmian Canal Commission)

Yield Point.....	37,093 lbs. per sq. in.
Tensile Strength	72,281 lbs. per sq in.
Elongation in 2 in.....	34%
Reduction of Area.....	32 "

Compression

Elastic Limit.....	12,000 to 25,500 lbs. per sq. in.
--------------------	-----------------------------------

Specifications for the Inspection of Materials, U. S. Navy

(As in force Oct. 1, 1917)

Sand Cast Materials

	Yield Point Lbs. per Sq. In. Minimum	Ultimate Tensile Strength Lbs. per Sq. In. Minimum	Elong- ation in 2 in. Minimum
Monel Metal	32,500	65,000	25%
Manganese Bronze	30,000	65,000	20 "
Gun Bronze	15,000	30,000	15 "
Steel—Special	57,000	90,000	20 "
“ Class A	35,000	80,000	17 "
“ Class B	30,000	60,000	22 "

Rolled Materials

	Yield Point Lbs. per Sq. In. Minimum	Ultimate Tensile Strength Lbs. per Sq. In. Minimum	Elong- ation in 2 in. Mini- mum
Monel Metal			
Rounds and Squares:			
Up to and including			
1 inch	40,000	80,000	25%
1 $\frac{1}{16}$ inches to and in- cluding 1 $\frac{11}{16}$ inches	50,000	85,000	28 "
1 $\frac{3}{4}$ inches to and in- cluding 2 $\frac{7}{16}$ inches	45,000	80,000	30 "
2 $\frac{1}{2}$ inches to and in- cluding 3 $\frac{1}{2}$ inches	37,000	75,000	32 "
Over 3 $\frac{1}{2}$ inches	40,000	75,000	32 "
Rectangles	40,000	75,000	32 "
Hexagons	40,000	80,000	32 "
Manganese Bronze			
1 inch and below	72,000	36,000	28 "
Above 1 inch	70,000	35,000	30 "
Rolled Naval Brass			
Up to $\frac{1}{2}$ inch	60,000	27,000	35 "
$\frac{1}{2}$ inch to 1 inch	58,000	26,000	40 "
Over 1 inch	54,000	25,000	40 "

THE BAYONNE CASTING CO.

Influence of Increased Temperatures on the Strength of Monel Metal as Compared with Certain Other Metals and Alloys

THE strength of various metals and alloys at ordinary temperatures is well known and the selection of the proper size piece of a suitable material is comparatively easy. Little is known, however, of the strength of these materials at higher temperatures and it is only by extended investigation of pieces tested at these temperatures that a safe basis for selection may be obtained.

Through the courtesy of the "Valve World" we are able to present the results of an extended investigation by Messrs. Bregowsky and Spring of the Crane Company, Chicago. These tables show both the tensile and torsional strengths of Monel Metal at varying temperatures. We are unable to cover this subject completely in the present limited space and will be very glad to furnish further details and tests to those who are interested, including the results of a set of tests made in the Physical Laboratory of the International Nickel Company. We have also prepared a list of the more important journal references. This is at the disposal of those who wish to inquire for it.

The following tables give comparisons with most of the metals in ordinary use, and reference to them shows that Monel Metal is superior to the majority in this respect both where its tensile and torsional strength at high temperatures are concerned. It is naturally greatly superior to the usual anti-acid metals such as copper and bronze alloys, all of which have low melting points.

Some idea of its ability in this respect may be had from a few typical comparisons. For example, at 70° F., the tensile strength of 30% rolled nickel steel is 94,498 lbs.; that of rolled Monel 104,900 lbs.; at 1030° F., nickel steel shows but 36,350 lbs., Monel Metal 47,200 lbs. Where torsional strength is concerned, 35% nickel steel shows but 25,350 lbs. at 800° F., while the torsional strength of Monel Metal at the same temperature is 40,610 lbs., other comparisons being even more favorable, viz.: 3½% nickel vanadium steel at 800° F., 14,340 lbs.; open hearth machinery steel 26,530 lbs.

MONEL METAL

Influence of Temperature upon Tensile Strength

Rolled Rod Brass

Fahr.	Tensile Strength Lbs. per Sq. in.	Elastic Limit Lbs. per Sq. in.	Elongation per cent. in 2"	Reduction of Area
70°	54450	45000	16.4%	18.0%
300°	52700	43200	26.6%	34.2%
450°	49000	39100	21.9%	26.0%
525°	—	—	—	—
600°	35050	23735	14.9%	17.8%
750°	18740	15050	17.2%	21.3%
950°	—	—	—	—
1030°	—	—	—	—

Rolled 30% Nickel Steel

70°	94498	39850	51.2%	59.8%
300°	97000	37100	64.1%	65.0%
450°	84950	32250	62.5%	65.0%
525°	83000	26200	59.4%	66.8%
600°	69575	25650	56.3%	72.6%
750°	45650	21100	43.0%	59.4%
950°	—	—	—	—
1030°	36350	15500	37.5%	55.7%

Rolled Monel Metal

70°	104900	78350	31.3%	61.7%
300°	97400	58500	29.7%	57.8%
450°	97800	58690	29.7%	51.0%
525°	96400	58400	32.8%	59.5%
600°	89600	57950	32.8%	59.5%
750°	67600	42550	28.1%	58.1%
950°	—	—	—	—
1030°	47200	26800	28.1%	60.7%

Cold Rolled Shafting (Bessemer)

70°	82800	76800	21.9%	49.5%
300°	91850	77100	21.9%	39.1%
450°	96083	72850	21.9%	38.7%
525°	96250	75300	18.8%	37.5%
600°	88525	54275	25.0%	44.2%
750°	—	—	—	—
950°	39250	30500	35.2%	78.0%
1030°	—	—	—	—

THE BAYONNE CASTING CO.

MONEL METAL

Influence of Temperature upon Torsional Strength

$\frac{7}{8}$ " Rolled Monel Metal

Fahr.	Torsional Strength	Elastic Limit	Twist
70°	94610	45510	12 turns 150°
385°	83030	33940	5 turns 0°
600°	72290	31300	5 turns 205°
800°	40610	10910	6 turns 240°

$1\frac{1}{8}$ " Rolled Monel Metal

70°	91990	37780	11 turns 150°
385°	78030	36140	4 turns 320°
600°	{ 54210	19800	4 turns 340°
	{ 59591	26123	4 turns 90°
800°	38600	10680	7 turns 50°

.35 Carbon Cold Rolled Steel

70°	83840	42540	2 turns 280°
385°	76650	36800	2 turns 30°
600°	{ 15920	2040	8 turns 230°
	{ 17100	4090	9 turns 195°
800°	7180	1630	39 turns 195°

Vanadium Tool Steel

70°	137295	54100	0 turns 345°
385°	124080	37550	1 turns 250°
600°	67710	17820	0 turns 320°
800°	—	—	—

Rolled Rod Brass

70°	51200	32600	2 turns 225°
385°	43780	22180	2 turns 185°
600°	14190	4100	5 turns 40°
800°	—	—	—

Tobin Bronze

70°	61200	26850	2 turns 155°
385°	36560	9800	4 turns 0°
600°	{ 9920	1630	4 turns 15°
	{ 8860	3270	3 turns 255°
800°	—	—	—

Elephant (Phosphor) Bronze

70°	70000	34250	12 turns 95°
385°	51020	21240	1 turns 215°
600°	19920	6560	15 turns 200°

Delta Metal

70°	61630	26940	0 turns 180°
385°	42860	14600	3 turns 235°
600°	3265	1360	4 turns 300°

THE BAYONNE CASTING CO.

MONEL METAL

Influence of Temperature upon Torsional Strength

Parsons Manganese Bronze

Fahr.	Torsional Strength	Elastic Limit	Twist
70°	61630	22040	2 turns 5°
385°	37630	13060	3 turns 110°
600°	8980	3260	2 turns 10°

Cold Rolled Shafting

70°	72400	41050	3 turns 152°
385°	82350	32800	1 turns 265°
600°	41175	26350	16 turns 0°
800°	12350	6550	8 turns 132°

Cumberland Cold Rolled Shafting

70°	68990	42710	3 turns 180°
385°	77210	29430	1 turns 345°
600°	33680	25460	9 turns 115°
800°	17250	0934	12 turns 0°

Openhearth Machinery Steel

70°	59590	24530	7 turns 130°
385°	49360	9830	3 turns 190°
600°	33061	7310	12 turns 120°
800°	26530	2450	61 turns 260°

3½% Nickel Vanadium Steel

70°	101200	57200	3 turns 140°
385°	82500	36200	3 turns 10°
600°	19509	13060	3 turns 110°
800°	14340	8560	8 turns 35°

25% Nickel Steel

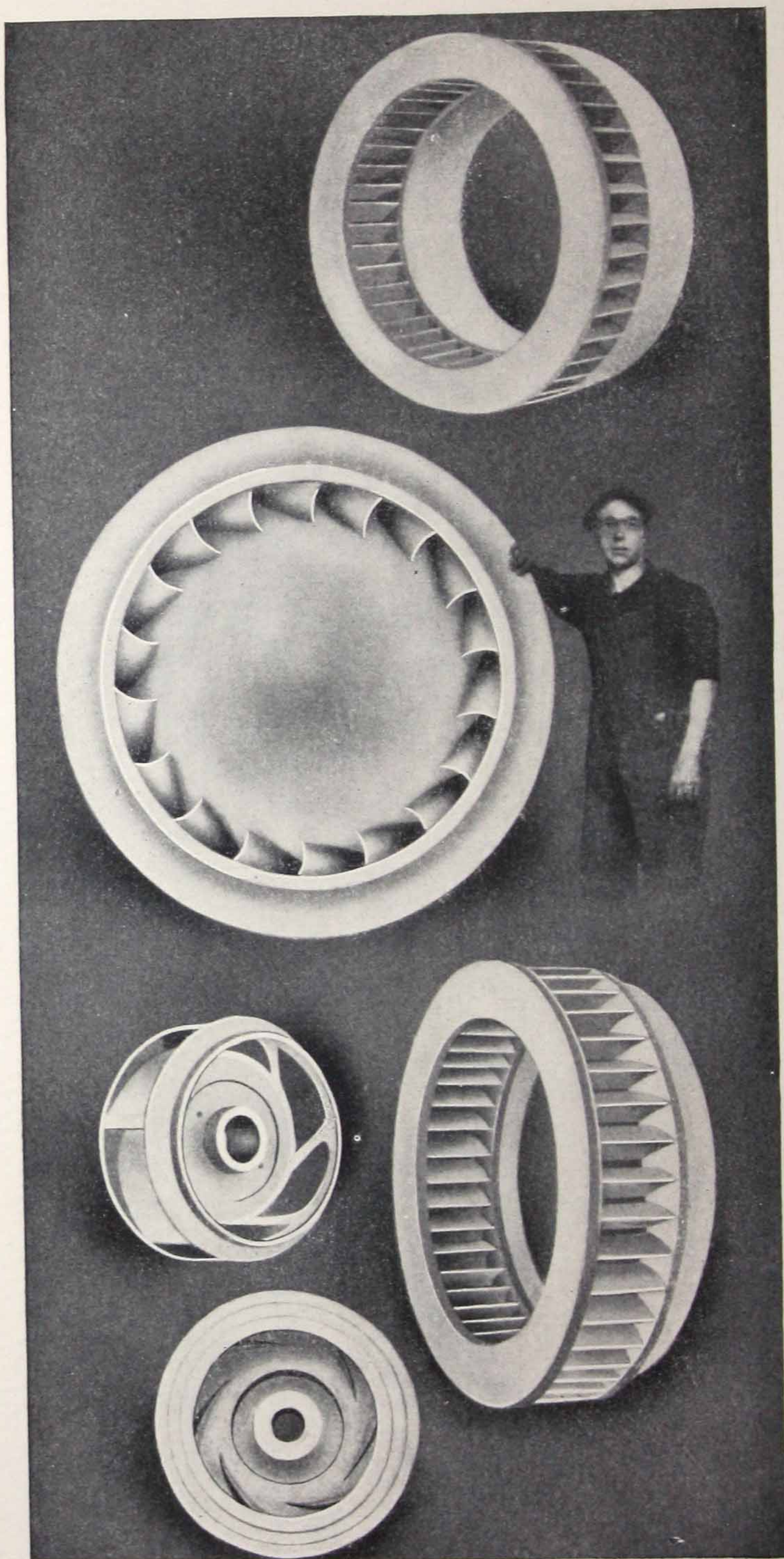
70°	91900	17250	9 turns 30°
385°	{ 64490	8150	8 turns 115°
	{ 66650	9050	8 turns 230°
600°	42300	6560	8 turns 40°
800°	—	6560	8 turns 132°

30% Nickel Steel

70°	104800	21800	11 turns 100°
385°	{ 78550	15700	6 turns 330°
	{ 84150	20650	7 turns 175°
600°	53170	10900	6 turns 195°
800°	25350	6040	9 turns 210°

THE BAYONNE CASTING CO.

MONEL METAL



A few of the many types of Impellers and
Turbine Wheels cast in Monel Metal

THE BAYONNE CASTING CO.

MONEL METAL

Monel Metal Castings

THE development in the casting of Monel Metal has covered a period of over eight years. In this time castings have been produced ranging in weight from a few ounces to 25,000 pounds each. The types and applications of these castings are too numerous and too varied to be covered in this booklet. Due to the fact that equal advantages are unobtainable with any other metal, Monel Metal castings have become an absolute necessity in the development and progress of many of the world's industries.

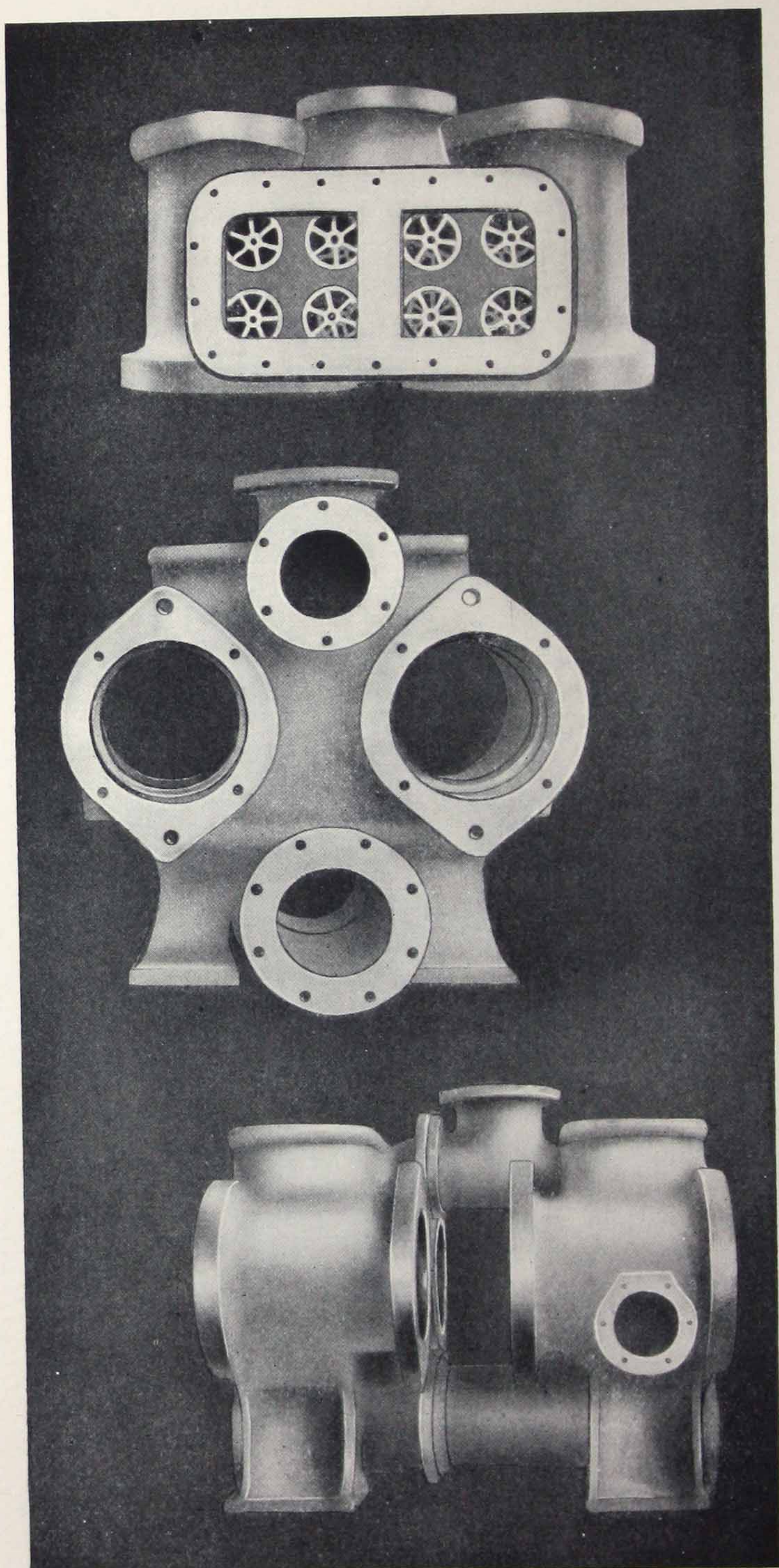
The present plant of The Bayonne Casting Company is equipped to produce Monel Metal castings of any size up to 25,000 pounds in weight in one piece. Owing to our specializing in the production of Monel Metal castings for the past eight years, we have been able to perfect our organization and develop our plant and methods to a high degree of efficiency.

During this period of development we have succeeded in producing a wide range of castings from patterns varying from very simple to the more intricate examples. We are accordingly in a position to produce good castings in Monel Metal to meet an extensive range of requirements, or we will be glad to place our data and experience in casting Monel Metal at the disposal of our customers in order that they may make their own castings. We will also be glad to supply data showing the many applications for which Monel Metal castings have proved to be the only thing that would meet the requirements satisfactorily.

Monel Metal castings have been shipped to all parts of the United States and to England, Italy, Japan and other foreign countries, largely for governmental use. One hundred thousand Monel Metal castings were used for transmission supports in connection with the construction of the Panama Canal. On the opposite page are shown a few of the many types of castings which have been produced in our foundry. The larger water wheel casting is one of seven produced for the Georgia Railway & Power Company's hydro-electric plant. These castings weigh 3,000 pounds each and the wheels run at high speed under a head of 600 feet, each unit producing 18,000 horsepower at 5,014 r.p.m.

THE BAYONNE CASTING CO.

MONEL METAL



Set of Pump Cylinders cast of Monel Metal

THE BAYONNE CASTING CO.

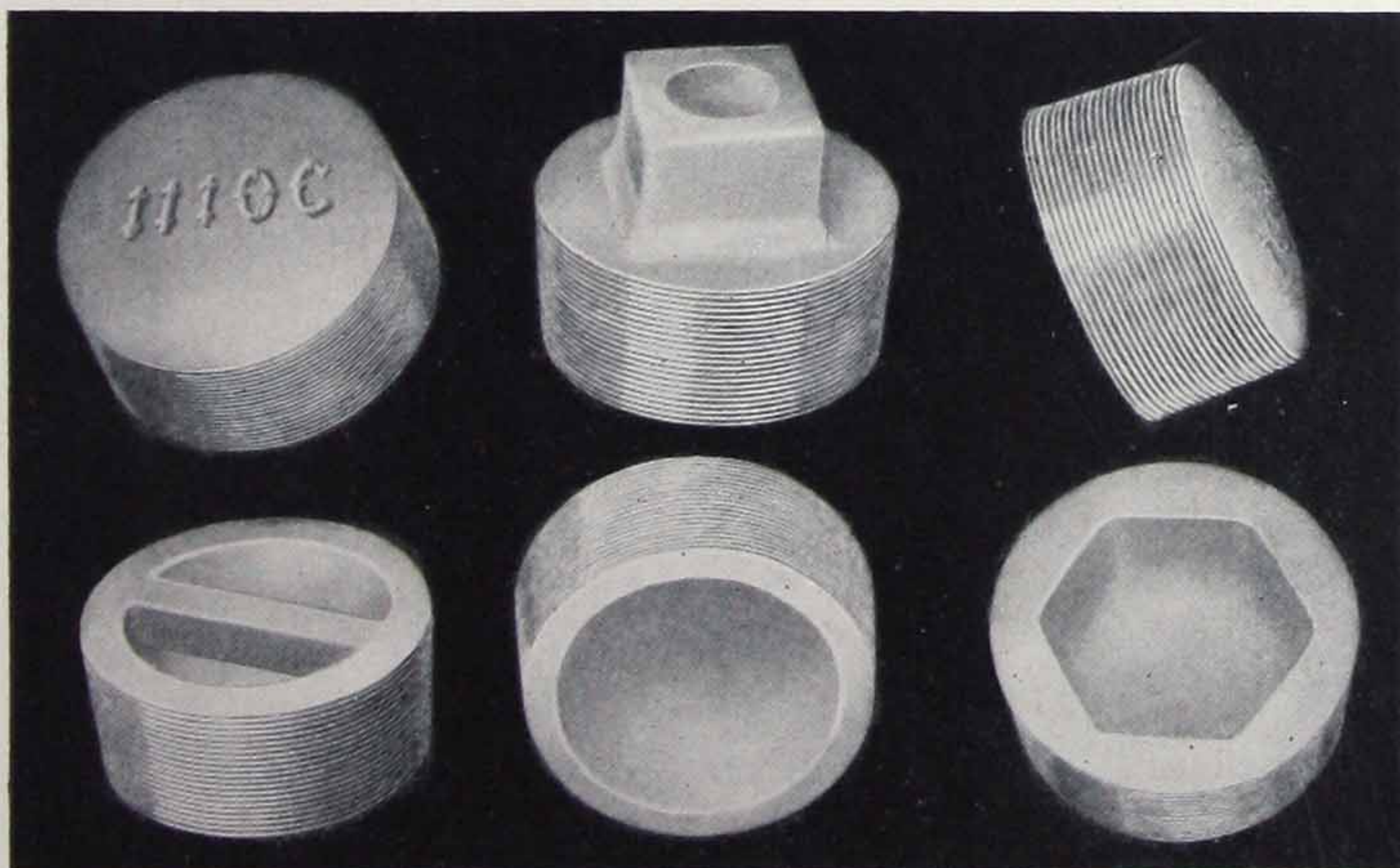
MONEL METAL

Monel Metal was specified for this to replace bronze after repeated failures by this material, the trouble experienced with bronze being pitting on the backs of the blades, due to the combined effects of corrosive gases and evacuation resulting from the high speed at which these wheels revolve.

On page 16 is illustrated a set of pump cylinders, cast of Monel Metal for 10'', 16'', and 18'' pumps, furnished by us, which have been in use for nine years in the plant of The International Nickel Company. These pumps handle salt water from the Kill-von-Kull, which is highly polluted by sewage and chemical waste, acids, etc., from the various manufacturing plants adjacent to it. After several years of service these pumps show no signs of deterioration.

As a typical example of the numerous instances in which Monel Metal has proved its superiority in a field unthought of in earlier years, its successful displacement of bronze in the refining of petroleum may be cited. The bronze plugs employed in the Burton gasoline stills had an effective life of but six weeks to a few months. After a year the first Monel Metal plugs furnished to the Standard Oil Company were still in service, and showed no sign of deterioration, so that at the present time their effective life cannot be determined. As a result, these stills in all parts of the country have been furnished with over 80,000 Monel Metal plugs.

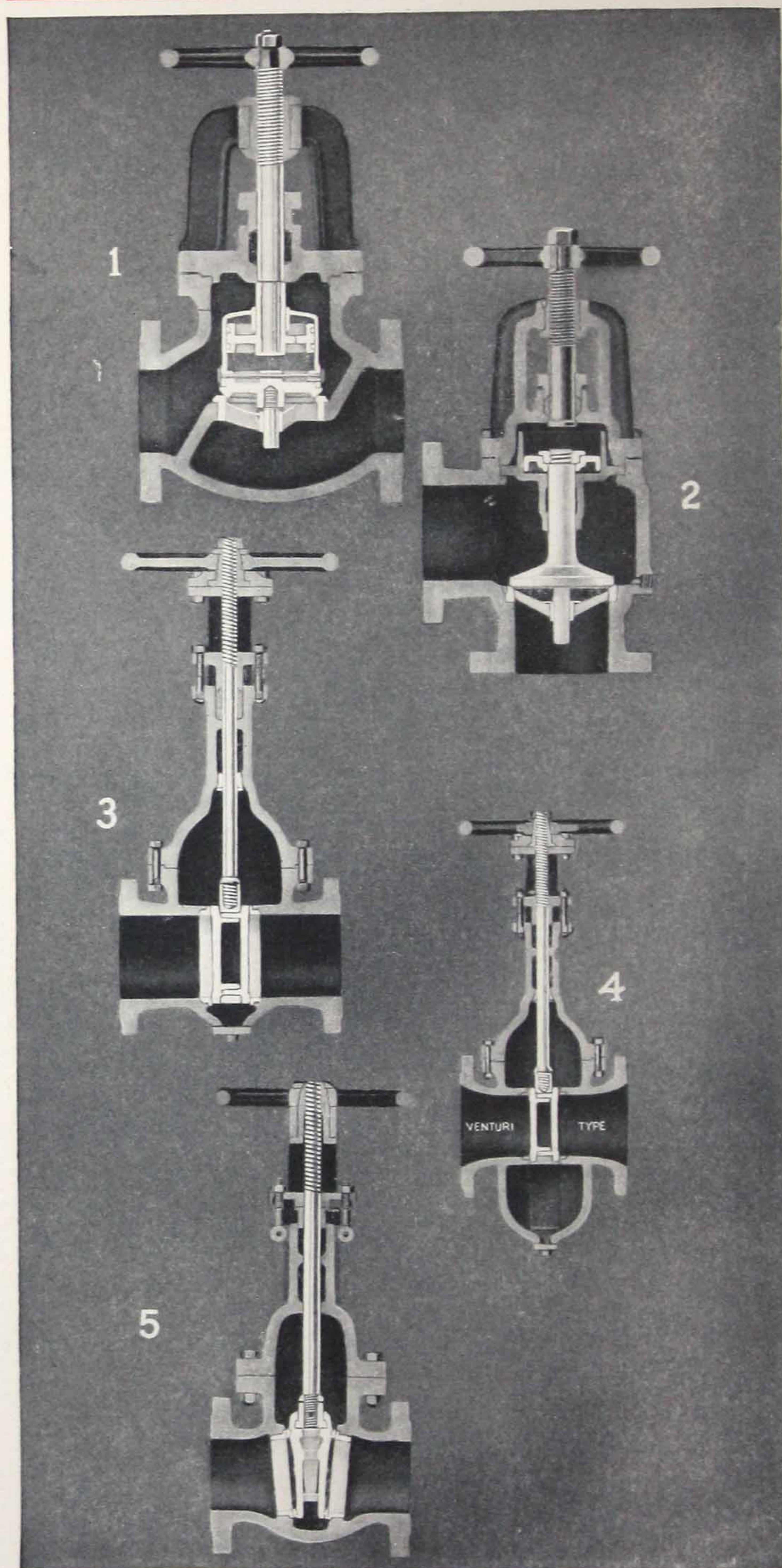
In view of the fact that castings vary greatly in difficulty of moulding it is not possible to quote a fixed figure. Prices will be made on receipt of patterns or detailed blue prints.



Monel Metal Plugs for Burton Gasoline Stills

THE BAYONNE CASTING CO.

MONEL METAL



Some Typical Sections of Monel Metal Trimmed Valves
for Superheated Steam

1. Edward Valve & Mfg. Co.
3 & 4. Chapman Valve & Mfg. Co.

2. Foster Eng. Co.
5. Pratt & Cady

THE BAYONNE CASTING CO.

MONEL METAL

Monel Metal for the Modern Power Plant

Monel Metal Trimmed Valves

FOR the high duty service demanded by super-heated steam, valves having a body of cast steel are required. Monel Metal has a great advantage in this connection in that its coefficient of expansion is nearly the same as cast steel. The result of this fact is that Monel Metal seats, discs, etc., expand and contract with the steel at about the same rate, suffering no changes of size or shape with repeated heating and cooling. Brass and bronze seats expand at a greater rate and become loose and distorted after the valve has been heated and cooled a few times.

The resistance which Nickel offers to the eroding and corroding effects of hot steam is well known. Monel Metal also possesses this property by virtue of its high Nickel content. The tensile strength of Monel Metal castings averages 70,000 pounds, while rolled Monel Metal shows an average tensile strength of 88,000 pounds, with a yield point of 54,000 pounds. Consequently it has a very substantial margin of safety over all ordinary demands for valve work.

Not only does Monel Metal possess these high strengths at ordinary temperatures, but it retains them in a large degree at the temperature employed in superheated steam work. Thus, according to results published in the *Valve World* of January, 1913, cast Monel Metal at 600° F., compared with the same metal at 70° F., retains—

73% of its elastic limit
75% of its tensile strength

while rolled Monel Metal retains—

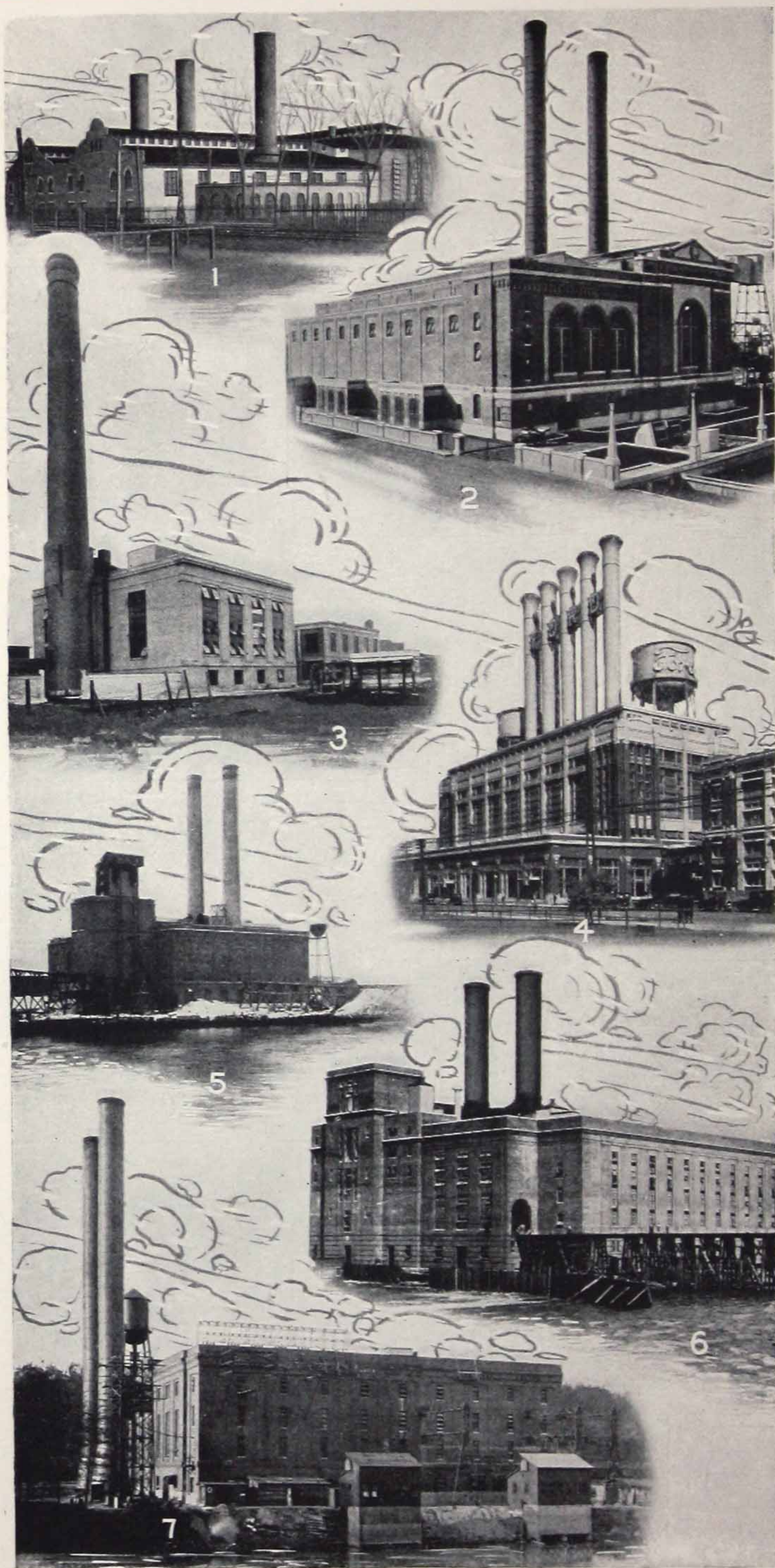
74% of its elastic limit
85% of its tensile strength

Under torsional test at the same temperatures, hot rolled Monel Metal rods retain 69% of their torsional elastic limit and 76% of their torsional strength.

In the illustration of a section of a Chapman gate valve, the seat, gates or discs and the spindle seat are of cast Monel Metal, while the spindle itself is of rolled Monel

THE BAYONNE CASTING CO.

MONEL METAL



Representative Power Houses using Monel Metal Valves

- | | |
|------------------------------------|---------------------------|
| 1. N. Y., N. H. & H., Cos Cob, Ct. | 2. Boston, Mass. |
| 3. Mass. Inst. Tech'y. | 4. Ford Motor Co. |
| 5. New Bedford Gas & Electric | 6. Buffalo Gas & Electric |
| 7. Lowellville, O., Gas & Electric | |

THE BAYONNE CASTING CO.

MONEL METAL

Metal. The Chapman Valve Manufacturing Company states in this connection:

"Monel Metal is non-corrodible and is ideal for valves working at high temperatures."

Writing us further on this subject they state:

"We recommend steel valves with complete Monel Metal trimmings which consist of spindles, seat rings and male and female gates, as shown by our list 65 1/2 Superheated Steam Steel Valves, in our catalogue No. 32, pages 141 to 149 inclusive. This is our best valve and is used on any pressure up to 600 pounds working steam pressure, under a total heat of 800° F.

Wherever we have put in the steel valves with Monel trimmings, we have experienced practically no trouble whatever and repeat orders for additional units is some evidence of actual worth.

Yours very truly,

THE CHAPMAN VALVE MANUFACTURING CO.,

(Signed) E. O. DAVIS,

Assistant Manager."

The experience of the Edward Valve and Mfg. Co., has been equally favorable, as shown by their letter:

"We have found that Monel Metal has no equal as a metal to withstand the action of high temperature and superheated steam. All of our high temperature and superheated steam valves have the seat, disc and stem of Monel Metal, and in our non-return valves the dashpot, seat, disc and stem are of Monel Metal.

At the present moment we are building a complete set of steel valves in all sizes up to 6 inches, which will be used in a new power station where the steam pressure will be 350 pounds to the square inch, and the total temperature approximately 680° F. In these valves we have supplied Monel Metal for all the trimmings.

Yours very truly,

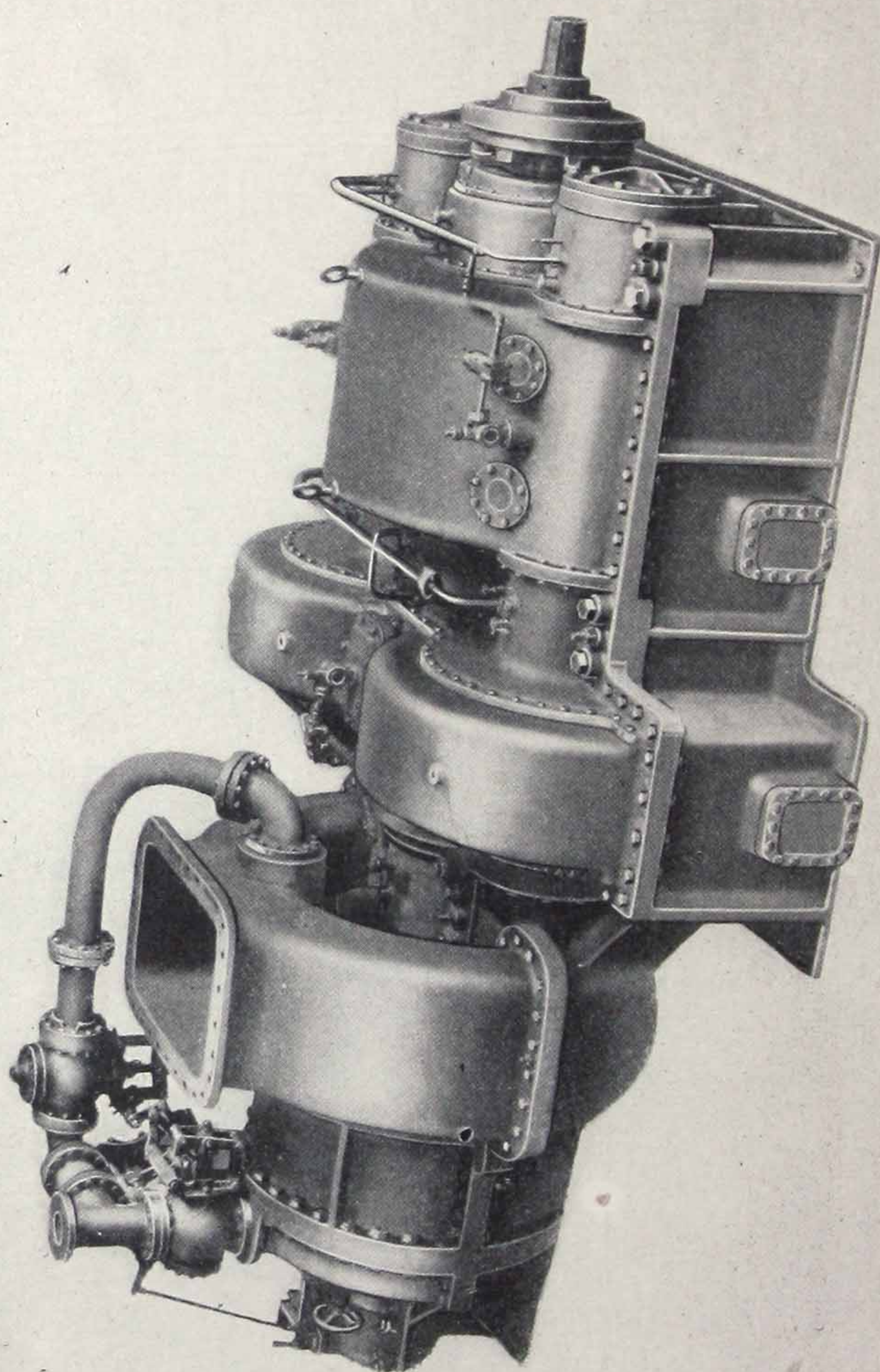
THE EDWARD VALVE & MFG. CO.,

(Signed) E. C. HITZE,

Manager Chicago Office."

THE BAYONNE CASTING CO.

MONEL METAL



Curtis Marine Type Turbine with Monel Metal Blading,
of which a large number are building by
The General Electric Co.

THE BAYONNE CASTING CO.

Monel Metal in Turbines

THE use of any material for turbines depends upon four unrelated or only partially related qualities and the selection of the material for use under any certain set of conditions depends largely upon the relative weights that are given to these qualities. These properties are:

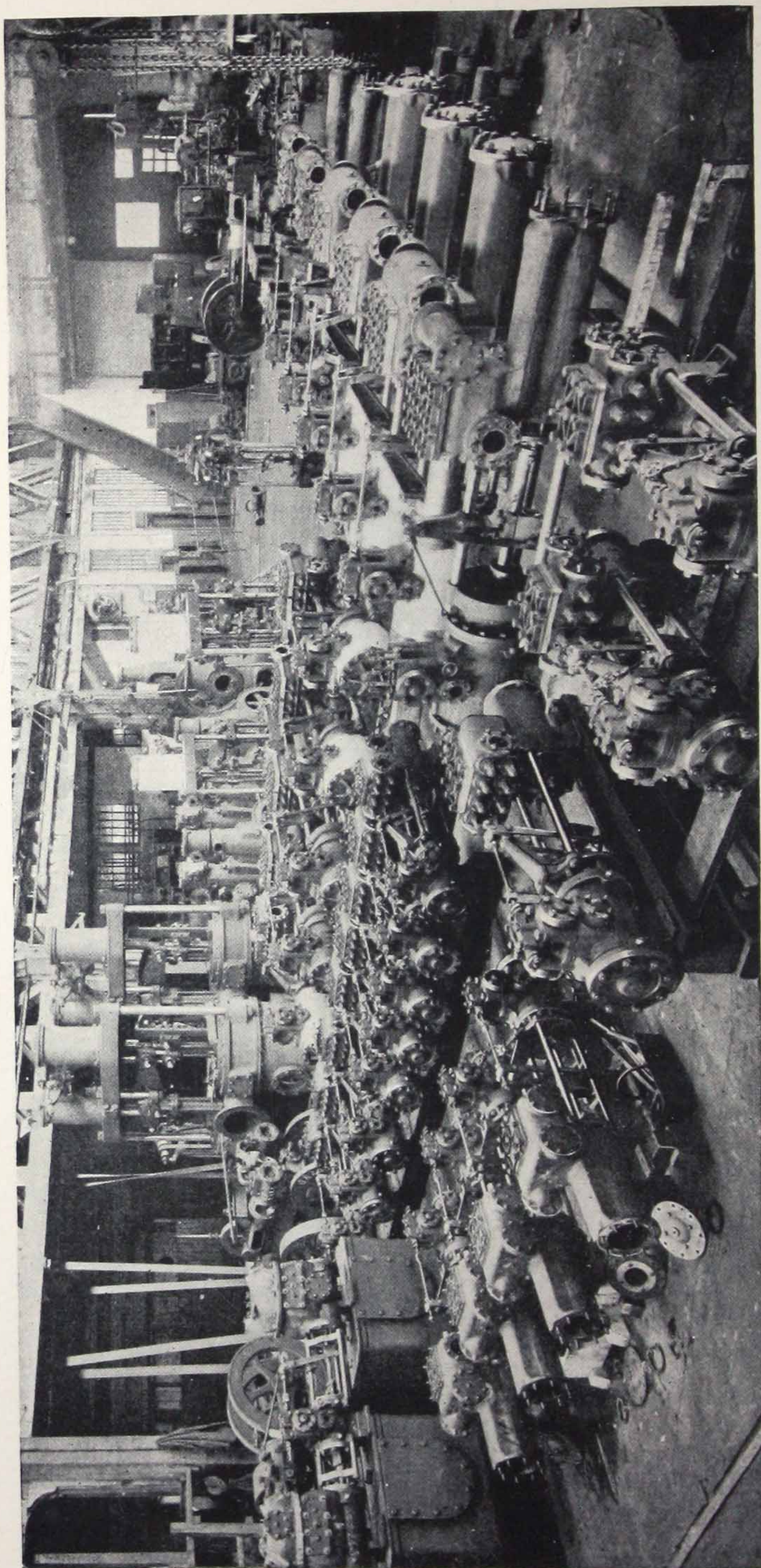
1. Ease with which the material can be produced in the required shape.
2. Strength at elevated temperatures.
3. Resistance to the erosive action of steam.
4. Resistance to corrosion.

Based on these qualities, materials for turbine blading have generally been taken from three classes of materials, brass, Monel Metal and nickel steel. Each of these materials to some extent, fulfills the four requirements just enumerated. Each naturally falls short of the perfection desired. Brass can be worked into the forms desired with comparative ease and economy. It is non-corrodible and resists the action of steam to some extent, but its strength is far from that necessary for the large, high speed machines now being built. Nickel steel is the antithesis of brass in these respects. Where strength is the one property demanded, it is most suitable but it does not possess that resistance to corrosion and erosion that is so desirable in all apparatus for handling steam.

Monel Metal occupies a middle ground in its properties between these two. It can be worked into all the necessary forms, while its resistance to the action of steam is remarkable. The turbine can be shut down without corrosion of the blades, and its strength, while not as great as that of heat treated nickel steel, is far superior to that of turbine brass.

Furthermore, as shown by tables in another part of this pamphlet, it retains this strength at elevated temperatures to a remarkable degree. In view of these properties, the rapid development of Monel Metal for turbine parts, chiefly for blading, is only what would be logically expected and we recommend it unqualifiedly for this purpose. Practically all naval vessels, many merchant ships, and quite a few industrial plants completed in the last few years have turbines fitted with Monel Metal blading. The consumption for this purpose during the past year exceeded 1,500,000 lbs.

MONEL METAL



Circulating and Air Pumps, Monel Metal Trimmed,
International Pump Co., Blake & Knowles Works

THE BAYONNE CASTING CO.

MONEL METAL

Monel Metal for Pumps

MONEL METAL where used for pump liners, rods, valves, etc., has proved its superiority over all other metals for this purpose due to its extreme toughness and resistance to abrasion and corrosion. This material has gradually become pre-eminent in this line. Monel Metal pump rods for ordinary pumping service will outlast the best grades of bronze several times over. In service these rods take a glass-like polish, which reduces the friction to a minimum. Due to this, the repacking of the pump is reduced by two-thirds. The packing does not harden, which, coupled with the non-corrosiveness of Monel Metal, virtually eliminates scoring. The advantages gained in ordinary service are more apparent where sulphuric acid, salt water and other acid or alkaline conditions are present.

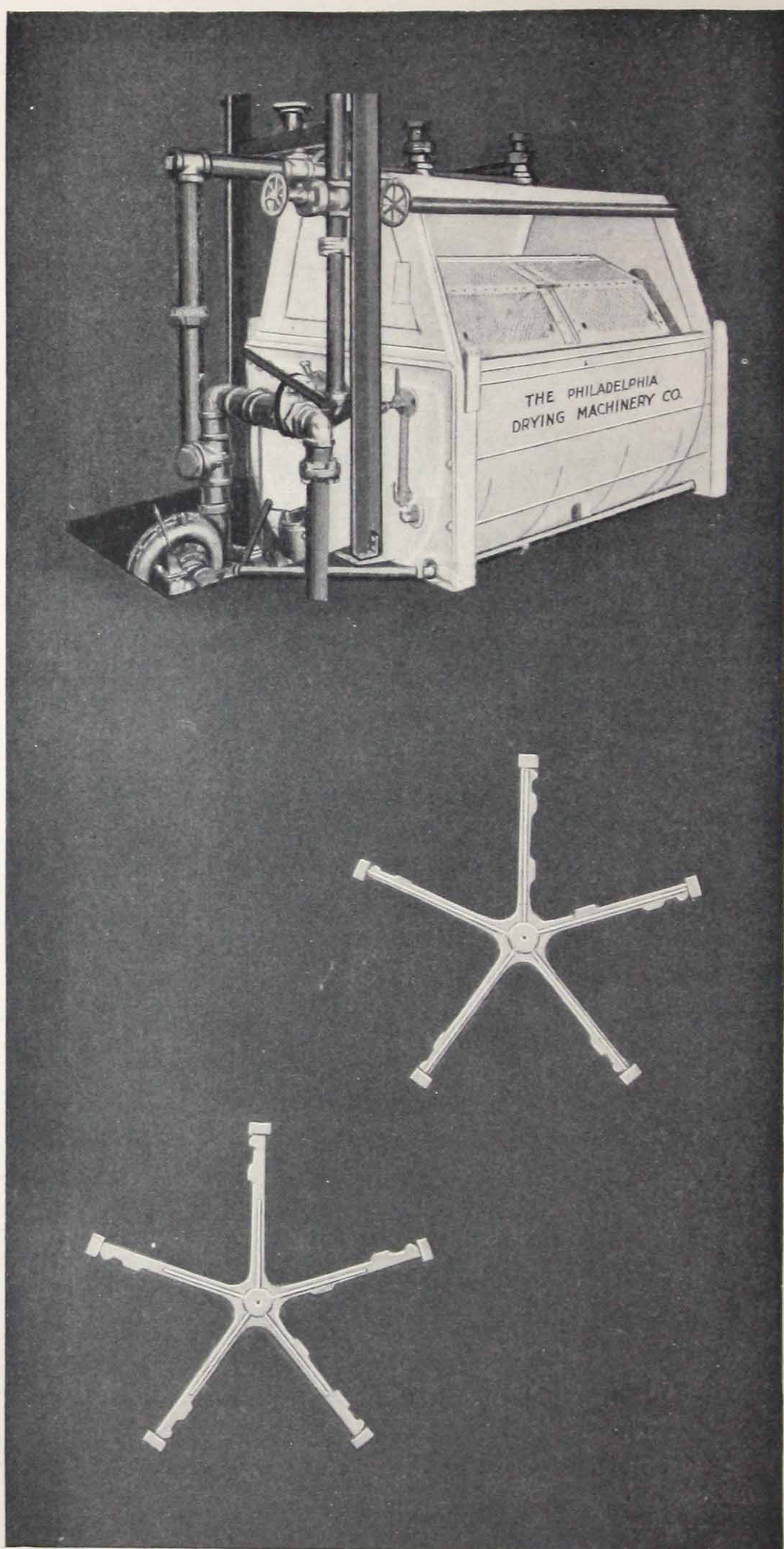
The photograph shows a group of pumps in the works of Worthington Pump & Machinery Corp.; Blake & Knowles plant, comprising horizontal and vertical, single and duplex types for handling water and air, in process of construction. This group represents but few of the large number of pumps now being rapidly pushed to completion, all of which are equipped with piston rods, valve rods or pump cylinder linings, etc., of Monel Metal. As the manufacturer writes us, "*Monel Metal was selected because of its perfect, non-corrosive and acid-resisting properties, together with the great strength and durability of the metal, it having all the virtues of copper without its drawbacks, and the strength of steel without any of its limitations.*"

Where special conditions make it desirable, the entire pump body can be cast of Monel Metal, as in the case of the set of pump castings shown on page 16. These pumps have been in service a number of years handling a combination of sewage, salt water, and acids, and have shown no signs of deterioration in that time, while little or no trouble has been experienced with the packing. The steam end of these pumps is of the usual construction, except that the piston rods are of Monel Metal.

As the result of a number of years' experience, we have accumulated considerable valuable data concerning the use of Monel Metal for pump liners and rods, and will be glad to place this at the service of the prospective user of pumps for acid, alkaline, or other corrosive solutions.

THE BAYONNE CASTING CO.

MONEL METAL



Hurricane Rotary-Dyeing and Bleaching Machine of
Monel Metal Complete

Typical Monel Metal Spiders for Dyeing Machines

THE BAYONNE CASTING CO.

MONEL METAL

Dyeing Machinery

DUE to the necessity of handling acid or strongly alkaline solutions, Monel Metal is very generally employed in manufacturing the parts of bleaching and scouring machinery and dyehouse equipment in general, where contact with these corrosive solutions is necessary. It enters into the construction of skein machines for dyeing wool and cotton; also for bleaching cotton and scouring wools and worsted. Likewise skein machines for dyeing silk, artificial silk or mercerized cotton, as well as for garment dyeing and bleaching machines for hosiery, underwear, etc.

In some of the above machines, Monel Metal is used only for the propeller shafts and propellers employed to agitate the solutions, while in others it is employed for the tank as well, so that the entire machine outside of the operating gears, belt pulleys and the like is manufactured of Monel Metal. This is true of the machine illustrated, about which the makers state: "We find that a machine built this way is suitable for practically all kinds of dyeing and bleaching and has the special advantage that it can be cleaned in a few minutes with water."

Some of the solutions which Monel Metal has to withstand in this industry are as follows:—

For dyeing wool and worsted yarn, etc.: Solution glauber salts 20%, bisulphate soda 10%, sulphuric acid 4%, at boiling temperature. Also acetic and oxalic acids in connection with sulphuric in the proportion of 6% to the weight of the material.

Chrome colors. Sulphuric acid 5%, bichromate potash 5% at boiling temperature in conjunction with the dye-stuff required.

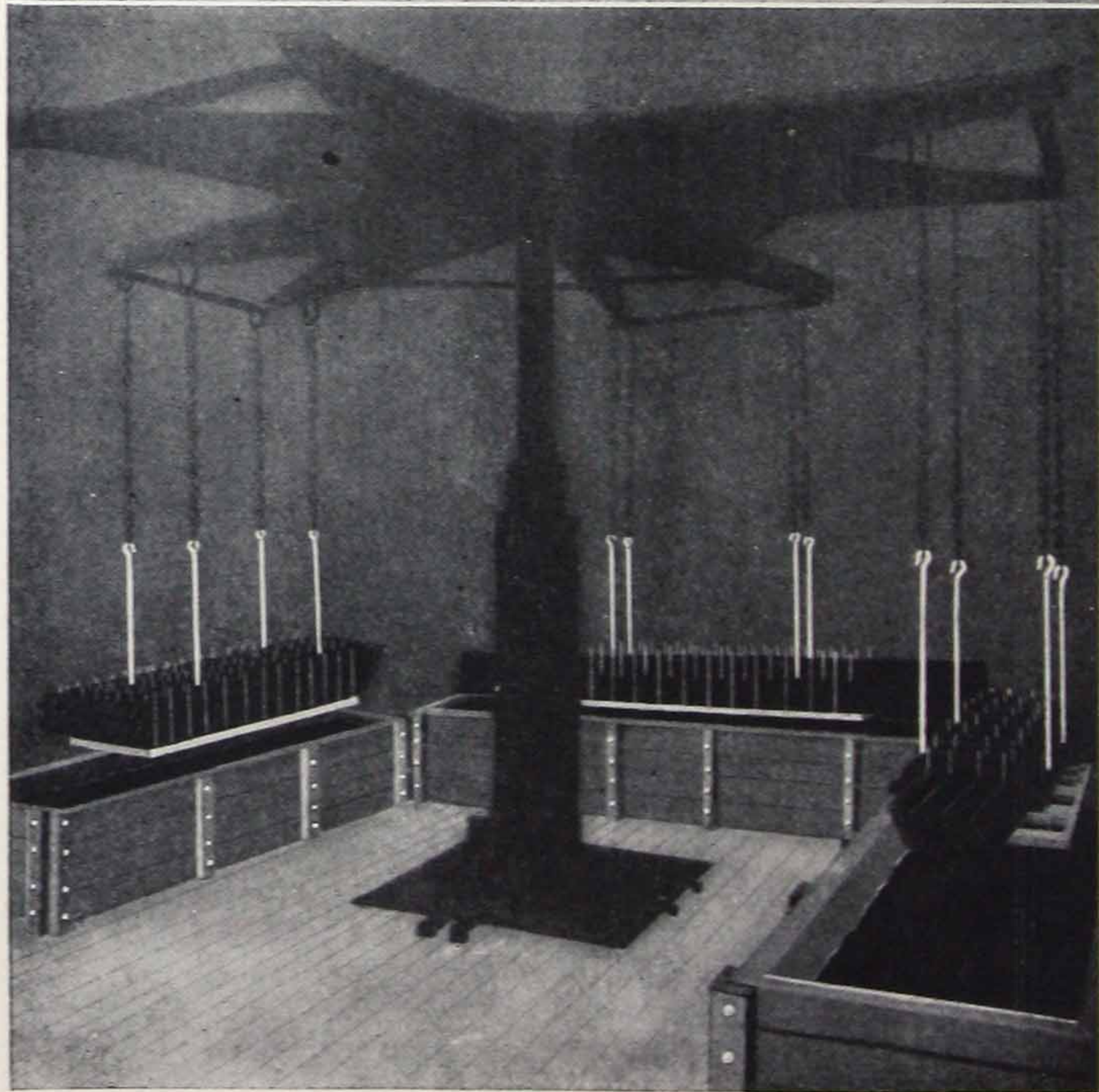
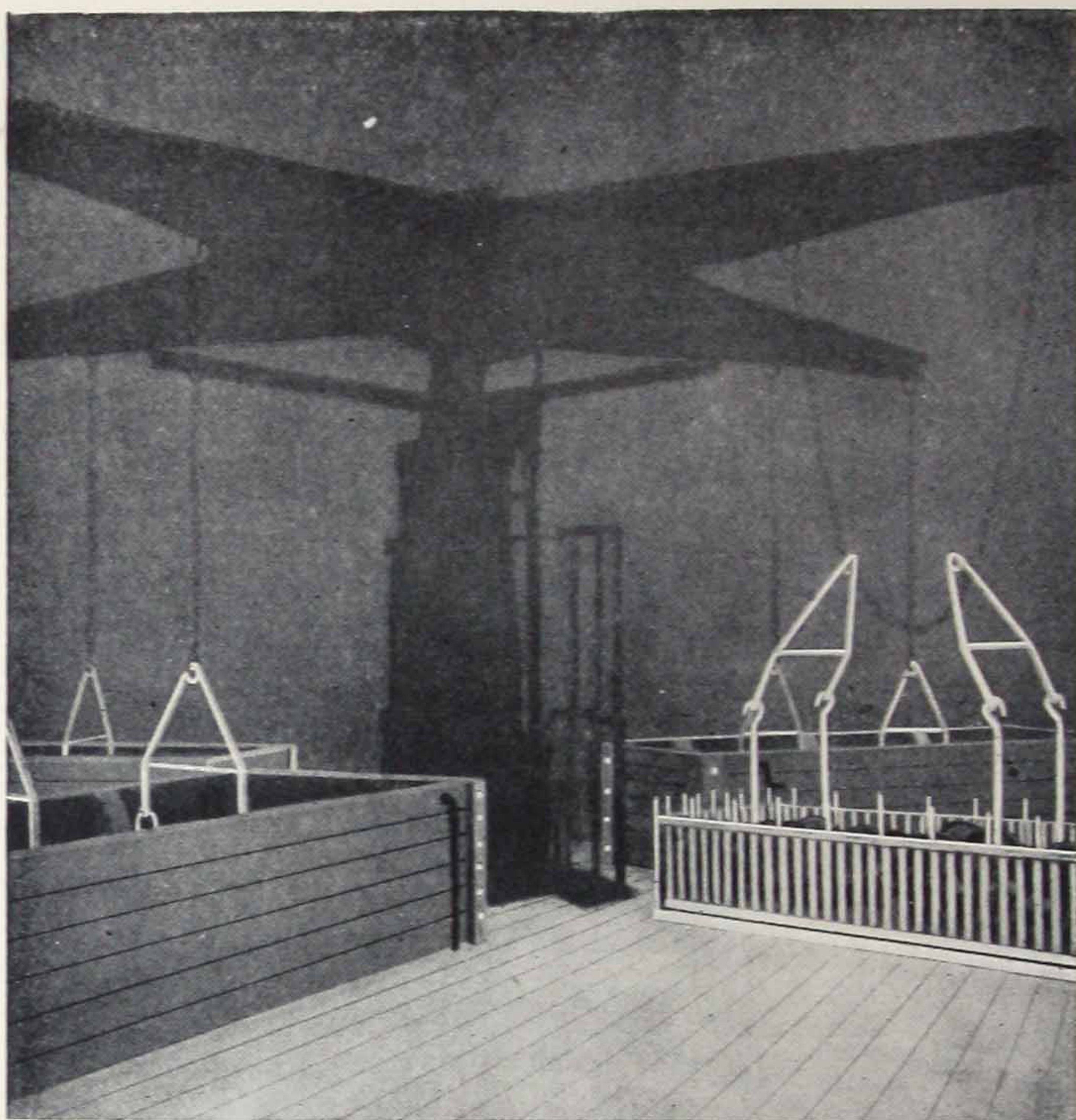
Manufacturers of dyeing machinery state further:

"We have found Monel Metal resists the action of these chemicals where bronzes do not."

"Monel Metal is superior to any other available metal for peroxide bleaching in that it forms no discoloring sediment when put to this use and has no adverse effect on the bath or the goods being bleached, *a statement that cannot be made of any other metal.* This makes it particularly valuable where one and the same machine may be used for peroxide bleaching as well as dyeing."

THE BAYONNE CASTING CO.

MONEL METAL



Monel Metal Crates, Pickling Pins, Tie Rods for Pickling Tanks, etc., used with Pickling Machines

THE BAYONNE CASTING CO.

MONEL METAL

Monel Metal for Pickling

DUE to its greatly superior resistance to corrosion, Monel Metal has been found much more advantageous for use in pickling than bronze or any of the other acid-resisting materials. It is largely employed for pickling tank fittings, tie rods, bolts, washers, crates, pins, and other metal parts which are immersed directly in the acid solution.

As experience is the best guide in matters of this kind, the prospective user can form his own opinion of its merits from the following letters:

"We have used Monel Metal rods for tying together wooden pickling vats for several years. These rods have proven very satisfactory and far superior to the acid-resisting bronze rods which we used prior to that time. In pickling sheet steel we use 60% sulphuric acid diluted to about 7% solution, at 180° to 200° F.

THE YOUNGSTOWN IRON & STEEL COMPANY,
C. B. CUSHWA, *Gen. Supt.*"

"We have used Monel Metal rods in the pickling of steel bars and sheets, and are very well pleased with them inasmuch as the life of the Monel Metal rods is much greater than that of anti-acid Metal which we used heretofore.

These rods resist the acid much longer than any other material we have ever used, and in addition to this they are much stronger, which is quite an item in drawing our tubs together and keeping them tight to prevent leakage. The pickling solution is 60% Sulphuric Acid to extent of 10%, the bath being kept at boiling temperature.

ALLEGHENY STEEL COMPANY,
Pittsburgh, Pa."

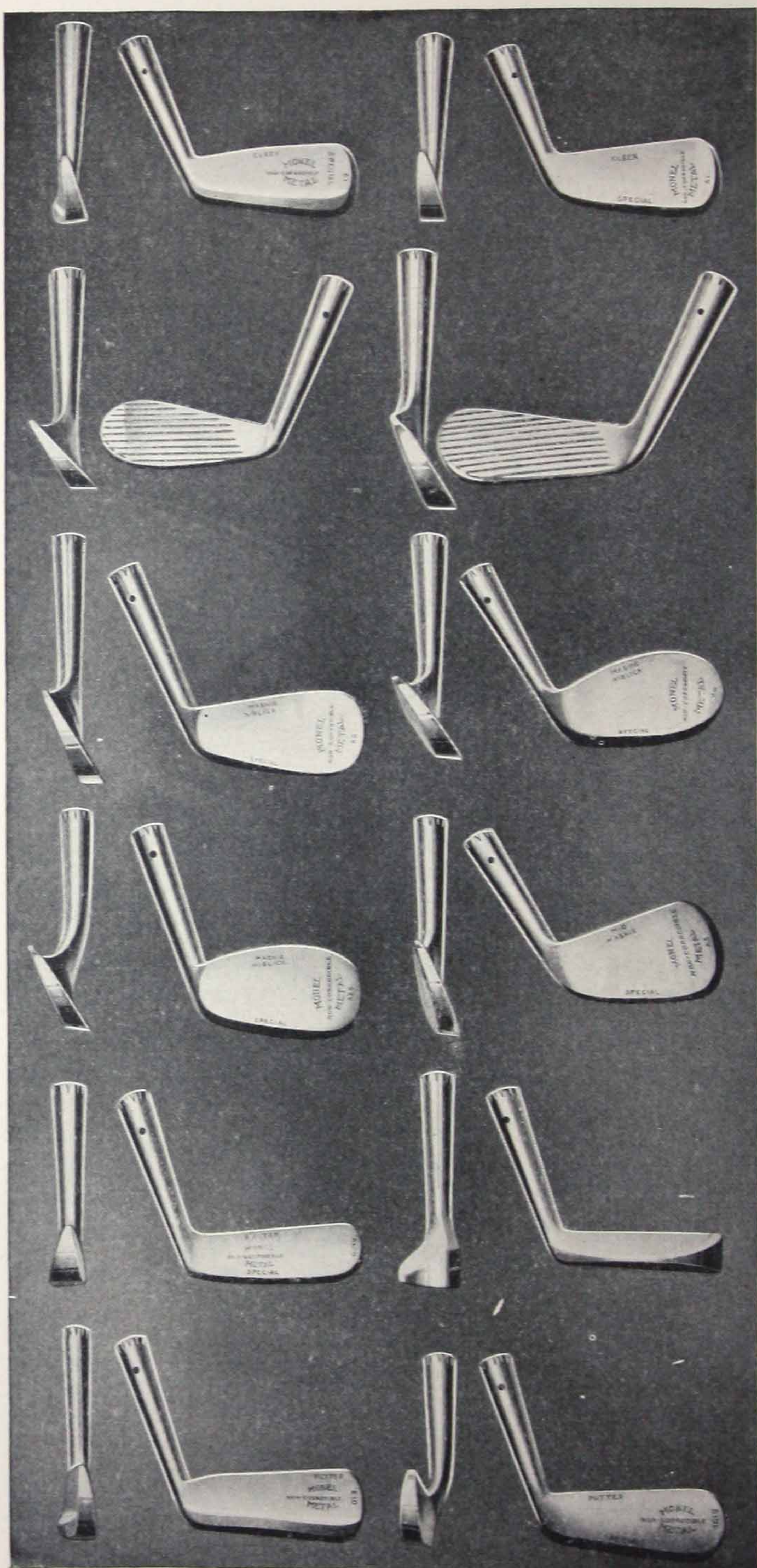
"We have used Monel Metal pickle pins that are exposed to 10% sulphuric acid up to 175° Fahrenheit for two years without appreciable loss. These pins are always washed with water after they leave the acid.

Monel Metal castings, such as rub plates, plugs and sockets, do not give as good service, but are better than any bronze we have ever been able to obtain. The principal reason for their failure is the fact that they are not washed off after immersion in acid, and the action of the acid and air will in time destroy them.

THE AMERICAN ROLLING MILL COMPANY,
Middletown, Ohio."

THE BAYONNE CASTING CO.

MONEL METAL



Monel Metal Golf Club Heads are cast in all of the popular models.

THE BAYONNE CASTING CO.

MONEL METAL

Monel Metal Golf Heads

GOLF CLUB HEADS that will not rust have been sought for years by every enthusiastic devotee of the sport, but such an ideal was not attainable until the advent of *Monel Metal*. Possessing all the qualifications of steel for this purpose with some characteristics that are superior, Monel Metal Heads compared with the iron or steel heads are in golf what the self-starting 1918 model is to the one-lunger of ten years ago in motoring.

Endless attempts have been made to produce a non-rusting golf head by using alloys of other metals or by giving steel heads a special treatment, but the softness of these alloys made them of no practical value, while the special treatment given to steel or iron was not lasting.

Every golfer has his own ideal of what his sticks should be. They must be right to a hair in weight, in balance, in lie, in breadth and length of head and other characteristics that make them just the thing for his individual play.

Monel Metal Golf Heads are the product of many years' experience in turning out heads that will exactly meet these distinctive requirements, plus the quality of being absolutely non-corrodible, which makes them the expert golfer's ideal. Every time an ordinary iron or steel head becomes rusty it has to be buffed on an emery wheel. This cuts away more of the metal every time it is done, thus lightening the head and destroying the fine balance of the club.

A little soap and water or rubbing with wet sand will restore a Monel Metal Golf Head to its normal finish, which is the dull polish of a razor or the appearance of a nickel piece after some use. No amount of wear or cleaning will alter the finish or balance of the head. If desired, Monel Metal Heads may be given a high polish which will be found much more lasting than on other metals.

In addition to having a tensile strength and hardness close to that of steel, a Monel Metal Golf Head has the further advantage of being more resilient. The ball leaves the club clean and with the right "feel."

Monel Metal when cast has the properties of forged steel; therefore, it is possible for us to duplicate any head with ease and enables us to copy from the best models of the leading Scotch cleekmakers without variation.

THE BAYONNE CASTING CO.

MONEL METAL

Monel Metal Rods

MONEL Metal Rods are carefully rolled under expert supervision in a modern mill. The process is practically that used in the rolling of steel. The ingots used are cast with large sink heads to insure sound metal, and before rolling they are chipped all over with pneumatic hammers to remove all superficial defects. Ample allowance is made in the reduction of the ingot to the rod, so that the crystalline cast structure of the metal is most thoroughly broken up and a fine-grain uniform product obtained at the finish.

The ingot is first heated to a proper temperature in a heating furnace, and then broken down or cogged to a billet of the proper size for the work at hand. This billet when cold is inspected carefully for cracks or flaws, which, if found, are chipped out with pneumatic hammers. Only sound billets are allowed to continue in the process. After inspection and preparation the cogged billet is again heated to the rolling or forging temperature and finished to the proper size and shape, according to the same procedure that is used in producing steel rods. In this operation attention is given to using a billet of sufficient cross sectional area to allow a thorough reworking of the material.

The rods are very close to shape and size, having an excellent surface, and practically the same tolerance applies to Monel Metal Rods that is in force on hot rolled steel.

We are able to supply these rods in round, half oval, square, rectangular and hexagonal shapes. Heavy rods, such as those over $3\frac{1}{2}$ " diameter, are usually hammered (forged) instead of rolled.

Besides the stock sizes of rounds, squares, and hexagons, a number of sizes of rectangles are also carried, and other sizes of rectangles can be obtained promptly from the mill. Round and square rods larger than the stock size specified can also be obtained promptly, and the mill facilities are such that large hammered rods can be obtained in any reasonable commercial size.

The applications of Monel Metal rods, as in the other products, are many and varied. We might mention a few of the most important, *i. e.*, Pump Rods, for which service Monel Metal is unequalled by any of the better bronzes. Every manufacturer should try at least one of these rods and become convinced of the economy of using Monel Metal throughout his plant for this service. Turbine blading and valve stems for power plants, both marine and stationary, demand a large tonnage of Monel Metal rods annually. Tie rods and pickle pins for steel mills, together with the various chemical industries also consume considerable quantities.

THE BAYONNE CASTING CO.

Weights of Monel Metal Rounds, Squares, and Hexagons

Weights per running foot

Size	Rounds	Squares	Hexagons	Size	Rounds	Squares	Hexagons
$\frac{1}{16}''$	.012	.015	.013	$1\frac{15}{16}''$	11.428	14.550	12.599
$\frac{1}{8}''$	.048	.061	.053	2''	12.178	15.504	13.426
$\frac{3}{16}''$	.108	.136	.119	$2\frac{1}{8}''$	13.747	17.503	15.156
$\frac{1}{4}''$	.190	.242	.209	$2\frac{1}{4}''$	15.411	19.622	16.991
$\frac{5}{16}''$	.297	.379	.327	$2\frac{3}{8}''$	17.171	21.863	18.921
$\frac{3}{8}''$	.428	.545	.472	$2\frac{1}{2}''$	19.027	24.225	20.977
$\frac{7}{16}''$	.583	.742	.643	$2\frac{5}{8}''$	20.977	26.708	23.127
$\frac{1}{2}''$	.761	.969	.839	$2\frac{3}{4}''$	23.022	29.312	25.382
$\frac{9}{16}''$	.963	1.226	1.062	$2\frac{7}{8}''$	25.162	32.038	27.741
$\frac{5}{8}''$	1.189	1.514	1.311	3''	27.399	34.884	30.207
$\frac{11}{16}''$	1.439	1.832	1.586	$3\frac{1}{4}''$	32.155	40.940	35.451
$\frac{3}{4}''$	1.712	2.180	1.887	$3\frac{1}{2}''$	37.291	47.481	41.113
$\frac{13}{16}''$	2.010	2.559	2.216	$3\frac{3}{4}''$	42.810	54.506	47.198
$\frac{7}{8}''$	2.331	2.968	2.570	4''	48.706	62.016	53.698
$1\frac{1}{16}''$	2.766	3.407	2.940	$4\frac{1}{4}''$	54.985	70.010	60.621
1''	3.044	3.876	3.356	$4\frac{1}{2}''$	61.644	78.489	67.933
$1\frac{1}{16}''$	3.436	4.376	3.788	$4\frac{3}{4}''$	68.714	87.452	75.757
$1\frac{1}{8}''$	3.853	4.906	4.248	5''	76.105	96.900	83.906
$1\frac{3}{16}''$	4.293	5.466	4.733	$5\frac{1}{4}''$	83.908	106.832	92.509
$1\frac{1}{4}''$	4.756	6.056	5.243	$5\frac{1}{2}''$	92.086	117.249	101.525
$1\frac{5}{16}''$	5.244	6.677	5.782	$5\frac{3}{4}''$	100.648	128.150	110.964
$1\frac{3}{8}''$	5.756	7.328	6.346	6''	109.590	139.536	120.823
$1\frac{7}{16}''$	6.291	8.009	6.934	$6\frac{1}{4}''$	118.916	151.406	131.105
$1\frac{1}{2}''$	6.849	8.721	7.551	$6\frac{1}{2}''$	128.617	163.761	141.800
$1\frac{9}{16}''$	7.432	9.463	8.194	$6\frac{3}{4}''$	138.703	176.600	152.910
$1\frac{5}{8}''$	8.039	10.235	8.863	7''	149.168	189.924	164.458
$1\frac{11}{16}''$	8.669	11.038	9.558	$7\frac{1}{4}''$	160.009	203.733	176.410
$1\frac{3}{4}''$	9.321	11.870	10.276	$7\frac{1}{2}''$	171.238	218.025	188.790
$1\frac{13}{16}''$	10.001	12.733	11.026	$7\frac{3}{4}''$	182.843	232.802	201.584
$1\frac{7}{8}''$	10.702	13.627	11.799	8''	194.827	248.064	214.797

Monel Metal Rods are carried in stock in the following sizes:

Rounds	$\frac{3}{16}$ " to 2" by $\frac{1}{16}$ ths
	2" to 3" by $\frac{1}{8}$ ths
	3" to 5" by $\frac{1}{4}$ ths
Squares	$\frac{1}{4}$ " to 2" by $\frac{1}{8}$ ths
Hexagons	$\frac{1}{2}$ " to 2" by $\frac{1}{8}$ ths

THE BAYONNE CASTING CO.

	$\frac{1}{8}$ "	$\frac{3}{16}$ "	$\frac{1}{4}$ "	$\frac{5}{16}$ "	$\frac{3}{8}$ "	$\frac{7}{8}$ "	$\frac{15}{16}$ "	1"	$1\frac{1}{16}$ "	$1\frac{1}{8}$ "	$1\frac{3}{16}$ "	$1\frac{1}{2}$ "	$1\frac{9}{16}$ "	$1\frac{5}{8}$ "	$1\frac{11}{16}$ "	$1\frac{3}{4}$ "	$1\frac{13}{16}$ "	$1\frac{7}{8}$ "	$1\frac{15}{16}$ "	2"												
$\frac{1}{16}$ "	.0303	.0454	.0606	.0757	.0908	.1060	.1211	.1363	.1514	.1665	.1817	.1968	.2120	.2271	.2423	.2574	.2725	.2877	.3028	.3180	.3381	.3482	.3634	.3785	.3987	.4088	.4239	.4391	.4542	.4694	.4845	$\frac{1}{16}$ "
$\frac{1}{8}$ "	.0908	.1211	.1514	.1817	.2120	.2423	.2725	.3028	.3331	.3634	.3937	.4239	.4542	.4845	.5148	.5451	.5753	.6056	.6359	.6662	.6965	.7268	.7570	.7873	.8176	.8479	.8782	.9084	.9387	.9690	$\frac{1}{8}$ "	
$\frac{3}{16}$ "		.1817	.2271	.2725	.3180	.3634	.4088	.4542	.4996	.5451	.5905	.6359	.6813	.7268	.7722	.8176	.8630	.9084	.9539	.9993	1.0447	1.0901	1.1355	1.1810	1.2264	1.2718	1.3192	1.3627	1.4081	1.4535	$\frac{3}{16}$ "	
$\frac{1}{4}$ "		.3028	.3634	.4239	.4845	.5451	.6056	.6662	.7268	.7873	.8479	.9084	.9690	1.0296	1.0901	1.1507	1.2113	1.2718	1.3324	1.3929	1.4535	1.5141	1.5746	1.6352	1.6958	1.7563	1.8169	1.8774	1.9380	$\frac{1}{4}$ "		
$\frac{5}{16}$ "				.4542	.5299	.6056	.6813	.7570	.8327	.9084	.9841	1.0598	1.1355	1.2113	1.2870	1.3627	1.4384	1.5141	1.5898	1.6655	1.7412	1.8169	1.8927	1.9683	2.0440	2.1197	2.1954	2.2711	2.3468	2.4225	$\frac{5}{16}$ "	
$\frac{3}{8}$ "					.9084	.9841	1.0598	1.1355	1.2113	1.2870	1.3627	1.4384	1.5141	1.5898	1.6655	1.7412	1.8169	1.8927	1.9683	2.0440	2.1197	2.1954	2.2711	2.3468	2.4225	2.4982	2.5739	2.6496	2.7253	2.8010	$\frac{3}{8}$ "	
$\frac{7}{8}$ "						.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	2.2971	2.3734	2.4497	2.5260	2.6023	2.6786	$\frac{7}{8}$ "	
$1\frac{1}{16}$ "							.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	2.2971	2.3734	2.4497	2.5260	2.6023	$1\frac{1}{16}$ "	
$1\frac{1}{8}$ "								.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	2.2971	2.3734	2.4497	2.5260	$1\frac{1}{8}$ "	
$1\frac{1}{4}$ "									.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	2.2971	2.3734	2.4497	$1\frac{1}{4}$ "	
$1\frac{3}{8}$ "										.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	2.2971	2.3734	$1\frac{3}{8}$ "	
$1\frac{1}{2}$ "											.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	2.2971	$1\frac{1}{2}$ "	
$1\frac{5}{8}$ "												.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	2.2208	$1\frac{5}{8}$ "	
$1\frac{3}{4}$ "													.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2.1445	$1\frac{3}{4}$ "	
$1\frac{7}{8}$ "														.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	$1\frac{7}{8}$ "	
2"															.8479	.9236	1.0000	1.0763	1.1526	1.2289	1.3052	1.3815	1.4578	1.5341	1.6104	1.6867	1.7630	1.8393	1.9156	1.9919	2.0682	2"

WEIGHTS OF
MONEL METAL FLATS
AND SQUARES
By sixteenths up to 2 in.

WEIGHTS OF
 MONEL METAL FLATS
 AND SQUARES
 By sixteenths up to 2 in.

$\frac{1}{8}$ "	$\frac{1}{4}$ "	$\frac{3}{8}$ "	$\frac{1}{2}$ "	$\frac{5}{8}$ "	$\frac{3}{4}$ "	$\frac{7}{8}$ "	1"	$1\frac{1}{8}$ "	$1\frac{1}{4}$ "	$1\frac{1}{2}$ "	$1\frac{3}{4}$ "	$1\frac{7}{8}$ "	2"	$2\frac{1}{8}$ "	$2\frac{1}{4}$ "	$2\frac{3}{8}$ "	$2\frac{1}{2}$ "	$2\frac{5}{8}$ "	$2\frac{3}{4}$ "	$2\frac{7}{8}$ "	3"	$3\frac{1}{8}$ "	$3\frac{1}{4}$ "	$3\frac{3}{8}$ "	$3\frac{1}{2}$ "	$3\frac{5}{8}$ "	$3\frac{3}{4}$ "	$3\frac{7}{8}$ "	4"	$4\frac{1}{4}$ "	$4\frac{1}{2}$ "	$4\frac{3}{4}$ "	5"	$5\frac{1}{4}$ "	$5\frac{1}{2}$ "	$5\frac{3}{4}$ "	6"	$\frac{1}{8}$ "																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
1.0296	1.0901	1.1507	1.2113	1.2718	1.3324	1.3929	1.4535	1.5141	1.5746	1.6352	1.6958	1.7563	1.8169	1.8774	1.9380	4.1183	4.3605	4.6028	4.8450	5.0873	5.3295	5.5718	5.8140	6.0562	6.2985	6.5408	6.7830	7.0253	7.2675	7.5098	7.7520	7.9943	8.2365	8.4788	8.7210	8.9633	9.2056	9.4478	9.6900	9.9323	10.1745	10.4168	10.6590	10.9013	11.1435	11.3858	11.6280	11.8703	12.1125	12.3548	12.5970	12.8393	13.0815	13.3238	13.5660	13.8083	14.0505	14.2928	14.5350	14.7774	15.0197	15.2619	15.5042	15.7465	15.9888	16.2311	16.4734	16.7157	16.9580	17.2003	17.4426	17.6849	17.9272	18.1695	18.4118	18.6541	18.8964	19.1387	19.3810	19.6233	19.8656	20.1079	20.3502	20.5925	20.8348	21.0771	21.3194	21.5617	21.8040	22.0463	22.2886	22.5309	22.7732	23.0155	23.2578	23.5001	23.7424	23.9847	24.2270	24.4693	24.7116	24.9539	25.1962	25.4385	25.6808	25.9231	26.1654	26.4077	26.6500	26.8923	27.1346	27.3769	27.6192	27.8615	28.1038	28.3461	28.5884	28.8307	29.0730	29.3153	29.5576	29.8000	30.0423	30.2846	30.5269	30.7692	31.0115	31.2538	31.4961	31.7384	31.9807	32.2230	32.4653	32.7076	32.9499	33.1922	33.4345	33.6768	33.9191	34.1614	34.4037	34.6460	34.8883	35.1306	35.3729	35.6152	35.8575	36.0998	36.3421	36.5844	36.8267	37.0690	37.3113	37.5536	37.7959	38.0382	38.2805	38.5228	38.7651	39.0074	39.2497	39.4920	39.7343	39.9766	40.2189	40.4612	40.7035	40.9458	41.1881	41.4304	41.6727	41.9150	42.1573	42.3996	42.6419	42.8842	43.1265	43.3688	43.6111	43.8534	44.0957	44.3380	44.5803	44.8226	45.0649	45.3072	45.5495	45.7918	46.0341	46.2764	46.5187	46.7610	47.0033	47.2456	47.4879	47.7302	47.9725	48.2148	48.4571	48.6994	48.9417	49.1840	49.4263	49.6686	49.9109	50.1532	50.3955	50.6378	50.8801	51.1224	51.3647	51.6070	51.8493	52.0916	52.3339	52.5762	52.8185	53.0608	53.3031	53.5454	53.7877	54.0300	54.2723	54.5146	54.7569	55.0000	55.2423	55.4846	55.7269	55.9692	56.2115	56.4538	56.6961	56.9384	57.1807	57.4230	57.6653	57.9076	58.1499	58.3922	58.6345	58.8768	59.1191	59.3614	59.6037	59.8460	60.0883	60.3306	60.5729	60.8152	61.0575	61.2998	61.5421	61.7844	62.0267	62.2690	62.5113	62.7536	62.9959	63.2382	63.4805	63.7228	63.9651	64.2074	64.4497	64.6920	64.9343	65.1766	65.4189	65.6612	65.9035	66.1458	66.3881	66.6304	66.8727	67.1150	67.3573	67.5996	67.8419	68.0842	68.3265	68.5688	68.8111	69.0534	69.2957	69.5380	69.7803	70.0226	70.2649	70.5072	70.7495	70.9918	71.2341	71.4764	71.7187	71.9610	72.2033	72.4456	72.6879	72.9302	73.1725	73.4148	73.6571	73.8994	74.1417	74.3840	74.6263	74.8686	75.1109	75.3532	75.5955	75.8378	76.0801	76.3224	76.5647	76.8070	77.0493	77.2916	77.5339	77.7762	78.0185	78.2608	78.5031	78.7454	78.9877	79.2300	79.4723	79.7146	79.9569	80.1992	80.4415	80.6838	80.9261	81.1684	81.4107	81.6530	81.8953	82.1376	82.3799	82.6222	82.8645	83.1068	83.3491	83.5914	83.8337	84.0760	84.3183	84.5606	84.8029	85.0452	85.2875	85.5298	85.7721	86.0144	86.2567	86.4990	86.7413	86.9836	87.2259	87.4682	87.7105	87.9528	88.1951	88.4374	88.6797	88.9220	89.1643	89.4066	89.6489	89.8912	90.1335	90.3758	90.6181	90.8604	91.1027	91.3450	91.5873	91.8296	92.0719	92.3142	92.5565	92.7988	93.0411	93.2834	93.5257	93.7680	94.0103	94.2526	94.4949	94.7372	94.9795	95.2218	95.4641	95.7064	95.9487	96.1910	96.4333	96.6756	96.9179	97.1602	97.4025	97.6448	97.8871	98.1294	98.3717	98.6140	98.8563	99.0986	99.3409	99.5832	99.8255	100.0678	100.3101	100.5524	100.7947	101.0370	101.2793	101.5216	101.7639	102.0062	102.2485	102.4908	102.7331	102.9754	103.2177	103.4600	103.7023	103.9446	104.1869	104.4292	104.6715	104.9138	105.1561	105.3984	105.6407	105.8830	106.1253	106.3676	106.6099	106.8522	107.0945	107.3368	107.5791	107.8214	108.0637	108.3060	108.5483	108.7906	109.0329	109.2752	109.5175	109.7598	110.0021	110.2444	110.4867	110.7290	110.9713	111.2136	111.4559	111.6982	111.9405	112.1828	112.4251	112.6674	112.9097	113.1520	113.3943	113.6366	113.8789	114.1212	114.3635	114.6058	114.8481	115.0904	115.3327	115.5750	115.8173	116.0596	116.3019	116.5442	116.7865	117.0288	117.2711	117.5134	117.7557	117.9980	118.2403	118.4826	118.7249	118.9672	119.2095	119.4518	119.6941	119.9364	120.1787	120.4210	120.6633	120.9056	121.1479	121.3902	121.6325	121.8748	122.1171	122.3594	122.6017	122.8440	123.0863	123.3286	123.5709	123.8132	124.0555	124.2978	124.5401	124.7824	125.0247	125.2670	125.5093	125.7516	125.9939	126.2362	126.4785	126.7208	126.9631	127.2054	127.4477	127.6900	127.9323	128.1746	128.4169	128.6592	128.9015	129.1438	129.3861	129.6284	129.8707	130.1130	130.3553	130.5976	130.8399	131.0822	131.3245	131.5668	131.8091	132.0514	132.2937	132.5360	132.7783	133.0206	133.2629	133.5052	133.7475	133.9898	134.2321	134.4744	134.7167	134.9590	135.2013	135.4436	135.6859	135.9282	136.1705	136.4128	136.6551	136.8974	137.1397	137.3820	137.6243	137.8666	138.1089	138.3512	138.5935	138.8358	139.0781	139.3204	139.5627	139.8050	140.0473	140.2896	140.5319	140.7742	141.0165	141.2588	141.5011	141.7434	141.9857	142.2280	142.4703	142.7126	142.9549	143.1972	143.4395	143.6818	143.9241	144.1664	144.4087	144.6510	144.8933	145.1356	145.3779	145.6202	145.8625	146.1048	146.3471	146.5894	146.8317	147.0740	147.3163	147.5586	147.8009	148.0432	148.2855	148.5278	148.7701	149.0124	149.2547	149.4970	149.7393	149.9816	150.2239	150.4662	150.7085	150.9508	151.1931	151.4354	151.6777	151.9200	152.1623	152.4046	152.6469	152.8892	153.1315	153.3738	153.6161	153.8584	154.1007	154.3430	154.5853	154.8276	155.0699	155.3122	155.5545	155.7968	156.0391	156.2814	156.5237	156.7660	157.0083	157.2506	157.4929	157.7352	157.9775	158.2198	158.4621	158.7044	158.9467	159.1890	159.4313	159.6736	159.9159	160.1582	160.4005	160.6428	160.8851	161.1274	161.3697	161.6120	161.8543	162.0966	162.3389	162.5812	162.8235	163.0658	163.3081	163.5504	163.7927	164.0350	164.2773	164.5196	164.7619	165.0042	165.2465	165.4888	165.7311	165.9734	166.2157	166.4580	166.7003	166.9426	167.1849	167.4272	167.6695	167.9118	168.1541	168.3964	168.6387	168.8810	169.1233	169.3656	169.6079	169.8502	170.0925	170.3348	170.5771	170.8194	171.0617	171.3040	171.5463	171.7886	172.0309	172.2732	172.5155	172.7578	173.0001	173.2424	173.4847	173.7270	173.9693	174.2116	174.4539	174.6962	174.9385	175.1808	175.4231	175.6654	175.9077	176.1500	176.3923	176.6346	176.8769	177.1192	177.3615	177.6038	177.8461	178.0884	178.3307	178.5730	178.8153	179.0576	179.2999	179.5422	179.7845	180.0268	180.2691	180.5114	180.7537	180.9960	181.2383	181.4806	181.7229	181.9652	182.2075	182.4498	182.6921	182.9344	183.1767	183.4190	183.6613	183.9036	184.1459	184.3882	184.6305	184.8728	185.1151	185.3574	185.5997	185.8420	186.0843	186.3266	186.5689	186.8112	187.0535	187.2958	187.5381	187.7804	188.0227	188.2650	188.5073	188.7496	188.9919	189.2342	189.4765	189.7188	189.9611	190.2034	190.4457	190.6880	190.9303	191.1726	191.4149	191.6572	191.8995	192.1418	192.3841	192.6264	192.8687	193.1110	193.3533	193.5956	193.8379	194.0802	194.3225	194.5648	194.8071	195.0494	195.2917	195.5340	195.7763	196.0186	196.2609	196.5032	196.7455	196.9878	197.2301	197.4724	197.7147	197.9570	198.1993	198.4416	198.6839	198.9262	199.1685	199.4108	199.6531	199.8954	200.1377	200.3800	200.6223	200.8646	201.1069	201.3492	201.5915	201.8338	202.0761	202.3184	202.5607	202.8030	203.0453	203.2876	203.5299	203.7722	204.0145	204.2568	204.4991	204.7414	204.9837	205.2260	205.4683	205.7106	205.9529	206.1952	206.4375	206.6798	206.9221	207.1644	207.4067	207.6490	207.8913	208.1336	208.3759	208.6182	208.8605	209.1028	209.3451	209.5874	209.8297	210.0720	210.3143	210.5566	210.7989	211.0412	211.2835	211.5258	211.7681	212.0104	212.2527	212.4950	212.7373	212.9796	213.2219	213.4642	213.7065	213.9488	214.1911	214.4334	214.6757	214.9180	215.1603	215.4026	215.6449	215.8872	216.1295	216.3718	216.6141	216.8564	217.0987	217.3410	217.5833	217.8256	218.0679	218.3102	218.5525	218.7948	219.0371	219.2794	219.5217	219.7640	220.0063	220.2486	220.4909	220.7332	220.9755	221.2178	221.4601	221.7024	221.9447	222.1870	222.4293	222.6716	222.9139	223.1562	223.3985	223.6408	223.8831	224.1254	224.3677	224.6100	224.8523	225.0946	225.3369	225.5792	225.8215	226.0638	226.3061	226.5484	226.7907	227.0330	227.2753	227.5176	227.7599</

MONEL METAL

Monel Metal Sheets

THE practice now followed in rolling Monel Metal sheets is the culmination of nine years' experience plus a great deal of experimental work. In the course of this work trials were made with various shapes and sizes of ingots; methods of heating were investigated, special furnaces built and tested, and the problem of annealing and cleaning was very thoroughly studied. As a result, the established practice represents the best thought and endeavor, not only of the producers of Monel Metal, but that of a large number of other sheet specialists who contributed their advice and assistance.

The ingots used are 11"x11"x60" weighing about 1,850 lbs. each. These ingots are carefully chipped to remove surface defects, heated in soaking pits and rolled to sheet bars on a three-high bar mill. The resulting sheet bars are cut to length and cross rolled to sheets, using a heating furnace designed especially for the heating of Monel Metal. These sheets are squared in guillotine shears and box annealed, using natural gas to remove the oxide formed in the hot rolling. The soft sheets are then cold rolled to insure uniformity of thickness and trueness to gauge. Following this, they are reannealed in boxes with charcoal to insure the complete removal of all oxide. Finally they are either roller, or patent, levelled and re-sheared to exact size, the light gauge sheets being crated and the heavier sheets bundled before shipment. By this method Monel Metal sheets are produced uniform in gauge and texture with soft, thoroughly deoxidized surfaces which can be readily formed, stamped, spun and soldered.

Hot Rolled Monel Metal sheets can be obtained in practically the same sizes and gauges as Hot Rolled Sheet Steel.

The following are the stock sizes:

Hot-rolled sheets from No. 8 to No. 26, measure 36"x96".

Hot-rolled sheets from No. 4 to No. 7, measure 36"x84".

Hot-rolled sheets from No. 3 gauge, measure 36"x76".

Cold-rolled strips, maximum width 12", from .010 to .250" thick. Lighter gauges can be made in narrower widths.

For the production of cold-rolled sheets, sheet bars are used, produced as described above. These are first planed or milled to remove all defects, and insure an unblemished surface on the finished sheets. After milling, the bars are rolled cold on highly finished rolls to the proper size and gauge. These sheets are generally furnished soft-annealed but they can be supplied hard, or in any intermediate temper desired.

THE BAYONNE CASTING CO.

MONEL METAL

Wire Products

IN the manufacture of low-temperature heating devices such as car-heaters, as well as of high precision electrical instruments, Monel Metal, owing to its good electrical properties, has proved very satisfactory. Monel Metal has a resistance of 256 ohms per mil. ft. and a temperature coefficient of .0011 per degree F. Its practically nil temperature coefficient is an important feature when Monel Metal is used for electrical purposes.

Manufacturers of spark plugs have been using Monel Metal for electrodes for many years. When used in the heavier sizes it stands up under severe service, giving entire satisfaction. Practically all of the carburetors now manufactured in this country are furnished with needle valves of Monel Metal on account of its non-corrosive character. Wire rope in the form of tiller rope and sash cord has also been manufactured from Monel Metal for many years and is used in many places where great strength must be combined with non-corrodibility. In the manufacture of fountain-pens there are many valuable uses for Monel Metal, owing to the corroding influences of various kinds of ink. This also is true in the case of fishing-tackle which comes in contact with corrosive elements, such as salt water.

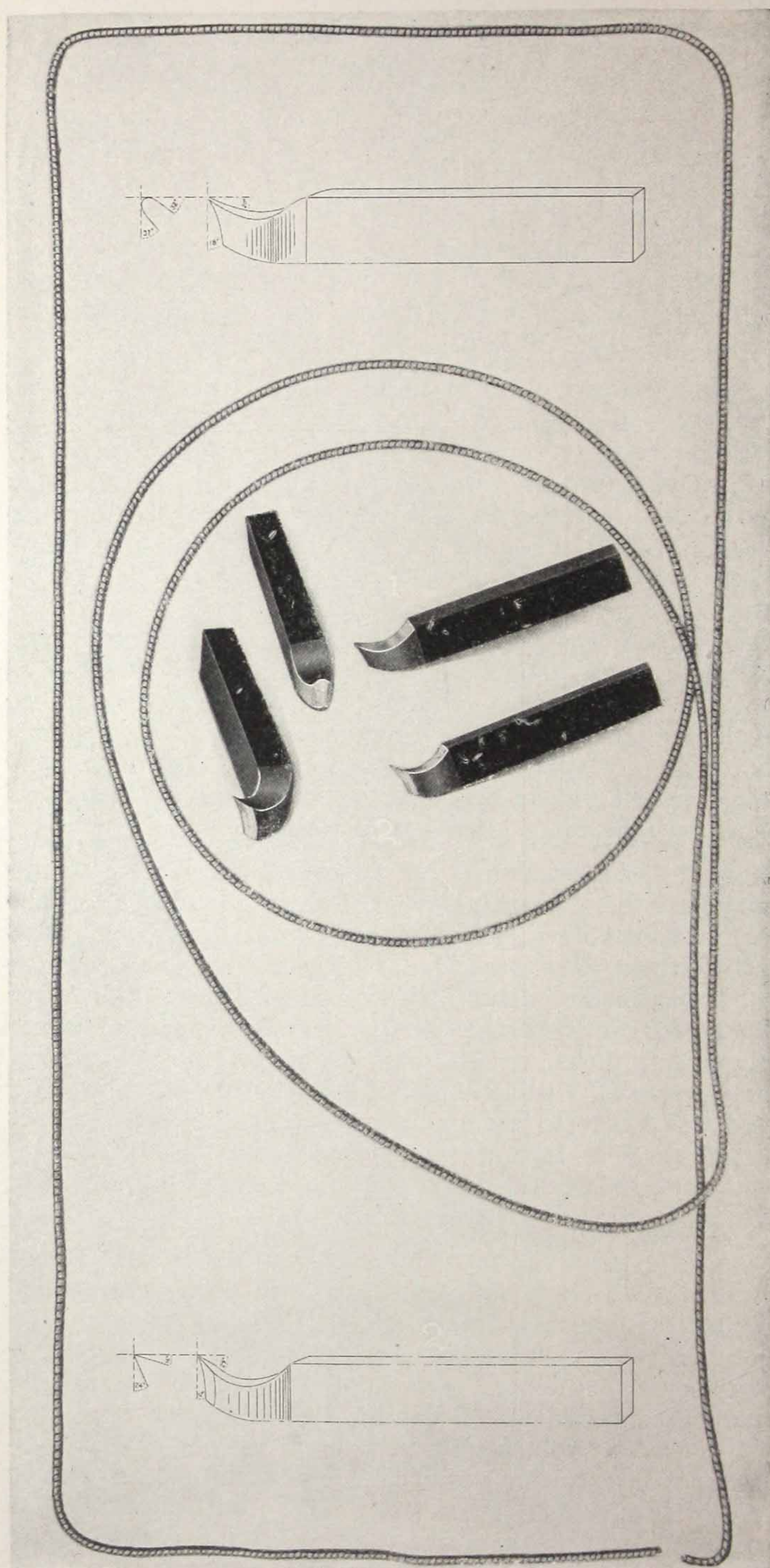
It is not possible to give a detailed description of the large number of applications of Monel Metal in this field but we would be glad to place at your disposal all data covering applications similar to your problems. Some of the numerous other applications of Monel Metal wire and rod products are: aeroplane parts, tie rods, snap fasteners, tacks, rivets, machine screw products, bolts, nuts, screws, escutcheons, buckles, parts for plumbing equipment, lock parts, eye-glass and spectacle mountings, surgical instruments, wood screws and washers, chains, metal trimming for office furniture, trunks, cameras and other similar articles.

As Monel Metal can be readily soldered with killed acid, brazes easily and can be welded either electrically or by the oxy-acetylene torch, it is equally adaptable to composite as well as to one-piece construction in any of the fields mentioned. Owing to its ductility it can be used for practically all products of the screw machine. It can also be furnished in a hard temper suitable for making low tension springs. While it is not essentially a spring material it has been used for this purpose in certain places where a non-corrosive metal is desired.

Monel Metal can be furnished in the form of wire or rod or rolled in the form of ribbon and can be supplied in coils, on spools, or cut to specified lengths.

THE BAYONNE CASTING CO.

MONEL METAL



Tools for Turning Monel Metal

1. Roughing Tool

2. Threading Tool

The border is only part of a typical turning from a Monel Metal Rod. The original was over 25 feet long.

THE BAYONNE CASTING CO.

MONEL METAL

Working Monel Metal

Machining Monel Metal

MONEL METAL machines with a long, tough chip, as will be noted on the opposite page, in this respect resembling copper, but requiring more power to cut.

Experiments made in our own laboratory indicate that rolled or drawn Monel Metal and mild steel require about the same power to machine. Cast Monel metal requires somewhat more power.

Owing to the great toughness of the metal, tools with a keen edge are necessary in all machine work. These tools should be ground with a decided rake or lip, and only the better grades of high speed steel used.

We have had recommended to us, by concerns using Monel Metal, several high speed steels that have given satisfaction—to wit—Poldi (OOOX-Extra), Rex A, Rex AA and Red Cut Superior. Stellite, a non-ferrous alloy, has also been recommended.

Directions for treating tools are furnished by the manufacturers and are followed to advantage. Angles to which tools should be ground are shown on opposite page.

Lubricants and cooling solutions are used by some, while others prefer to cut dry. For ordinary machine work Monel Metal may be cut dry very satisfactorily. Some of the lubricants that have given satisfaction are as follows:

- (1) Lard Oil and 10% turpentine (fine boring).
- (2) Machine Oil (general).
- (3) Mineral Lard Oil, plus 300 test burning oil (threading).
- (4) Lard Oil—Borax and Aquadag (cutting off).
- (5) Exanol (general).
- (6) Oakite (milling).

Cutting speeds vary greatly from a slow speed of 8 ft. per minute with heavy cut and feed, to a high speed of 250 ft. per minute with light cut and feed. In the latter case a Stellite tool was used with machine oil for lubricant. A good average speed for general work would be from 50 to 60 ft. per minute with $\frac{1}{8}$ " cut and $\frac{1}{32}$ " feed.

Where a smooth, bright, finishing is desired, a higher speed with light cut should be used, always remembering that the tool must be kept sharp.

THE BAYONNE CASTING CO.

MONEL METAL

Annealing

MONEL Metal rods are annealed by heating to any temperature between 800 and 1000 degrees centigrade, and the rods are progressively softened by increased temperatures between these two points. Heating above 1000 degrees centigrade does not give any additional softness.

Monel Metal sheets are annealed by heating to any temperature above 875 degrees centigrade. The degree of softness obtained is dependent upon the amount they are heated above this temperature.

Monel Metal castings are used as cast, without annealing.

In annealing Monel Metal the speed of heating and cooling is relatively unimportant, but it is essential that the material be held at the annealing temperature for a sufficient time to allow it to become heated through. Since the heat conductivity is low, this will take a considerably longer time than in the case of copper, brass or steel. It is recommended that Monel Metal be annealed wherever practicable buried in charcoal in tight boxes, so as to prevent the formation of oxide and it is possible to remove oxide already formed by this reducing anneal.

Pickling

PICKLING of Monel Metal is, at the best, an expensive and tedious operation, and it is advisable to anneal in charcoal wherever possible, so as to keep the metal from becoming covered with oxide. Where this cannot be done, pickling may be done as follows:

Make a 12-degree Beaumé solution of ferric sulphate in water. A large excess of ferric sulphate does little harm to the metal and greatly decreases the time of pickling, but tends to increase pickle consumption. Sufficient ferric sulphate should be kept in the solution at all times to prevent any deposits of copper. This solution works best at 100 to 140 degrees F.

Where the oxide is not too heavy, pickling can also be done with a hydrochloric acid solution of 1.1 specific gravity at boiling temperature.

THE BAYONNE CASTING CO.

MONEL METAL

In pickling Monel Metal, it should be kept strongly in mind that the scale is a mixed oxide of copper and nickel so that its solution puts copper in the bath, and also that Monel Metal has the property of cementing copper just as iron does. This cementation or "coppering" is prevented by the method described, but care should be taken to keep all iron pins and bars from any continued contact with the Monel Metal, and no iron band, wires or fasteners should be used.

During pickling, part of the scale is dissolved and the rest remains adhering to the metal so that the progress of the pickling should be observed by removing a piece of metal from the bath and washing with a jet of water or rubbing with a piece of waste. When the scale becomes loose so that it may be easily rubbed off, remove the metal and wash it with a jet of water or scrub with a brush to remove all adhering scale.

Forging

IN forging Monel Metal experience has shown that the following details should be observed:

1st. The best forging temperature lies between 900 and 1100 degrees centigrade, and care should be taken not to exceed the latter temperature.

2nd. In heating Monel Metal a low sulphur fuel is necessary, preferably oil or gas, and care should be taken not to have the flame conditions either strongly oxidizing, or strongly reducing.

3rd. Care should be taken to have the metal heated uniformly, which is best accomplished by repeatedly turning the ingot while in the furnace.

4th. The heat should be carried well past the point of work.

5th. If a forging of high strength is required, finish the forging at a temperature of 500-600° centigrade.

THE BAYONNE CASTING CO.

MONEL METAL

Polishing and Finishing Monel Metal

To manufacturers of novelties, plumbing fixtures, automobile trim, etc., it will be of interest to know that Monel Metal when polished and buffed takes the same finish and can hardly be distinguished from pure nickel; in fact, the color of Monel Metal is a trifle more attractive. For these purposes there is now being furnished considerable Monel Metal in its various forms.

In finishing Monel Metal, the instructions noted below will be found valuable.

Castings

In polishing castings it is necessary:

- 1st—Use a solid stone, of which there are several grades and makes. We have found Norton Company's Grade "Q," Grain No. 20; also Carborundum Company's Grade "G," Grain No. 16, very satisfactory.
- 2nd—A rag, wood, or canvas wheel coated with No. 40 emery.
- 3rd—A rag, wood, or canvas wheel coated with No. 120 emery.
- 4th—A rag, wood, or canvas wheel coated with No. 120 emery and finished with an ordinary buff, using buffing compound.

Hot Rolled Rods

In polishing rods it is necessary:

- 1st—A rag, wood, or canvas wheel coated with No. 90 emery.
- 2nd—A rag, wood, or canvas wheel coated with No. 120 emery.
- 3rd—A rag, wood, or canvas wheel coated with No. 120 emery and finished with an ordinary buff, using buffing compound.

Sheets

In polishing sheets it is necessary:

- 1st—A rag, wood, or canvas wheel coated with No. 90 emery.
- 2nd—A rag, wood, or canvas wheel coated with No. 150 emery.
- 3rd—A rag, wood, or canvas wheel coated with No. 150 emery and finished with an ordinary buff, using buffing compound.

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MONEL METAL

Manufactured Forms

RODS—rounds, squares, hexagons, rectangles, half ovals.

CASTINGS—from consumer's patterns.

FORGINGS.

WIRE—annealed and hard.

WIRE CLOTH.

WIRE ROPE.

BALL BEARINGS.

STRIP STOCK.

TUBES.

SHEETS.

BOLTS and NUTS.

LAG SCREWS.

SCREWS—wood and machine.

SCREW MACHINE PRODUCTS.

TIE RODS.

WASHERS.

NAILS AND RIVETS.

CHAIN.

GOLF CLUB HEADS.

All these forms are not manufactured by us, but we will be glad to refer you to the makers upon inquiry.

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MONEL METAL

Some Uses for which Monel Metal has Proved Superior

Power Plants

(High Pressure Superheated Steam)

- *† Valve trim (seats, discs, stems) for superheated and high pressure steam.
- † Turbine blading and shrouding, also various parts that come in contact with the steam.
- *† Valves and valve trim.
- *† Pump liners.
- † Pump rods.

Marine Installations

(Salt Water)

- *† Pump liners.
- † Pump rods.
- * Propellers (small and large, from small launches to battleships).
- †* Propeller shafts and boat trim, such as deck fittings, stern bushings, rudders, struts, stuffing boxes, shaft sleeves, etc.
- †† Marine Condenser parts, such as tubes, ferrules, etc.

Gas and Oil Engines

(Extremely High Temperature)

- † Valves for combustion engines (exhaust).
- * Ignition chambers for oil engines.
- w Wire—engine ignition, needle valves on carburetors, cables, wire cloth, electrical purposes.

Pickling and Chemical Works

(Acid Solutions at Various Temperatures)

- †* Tie rods—nuts and washers on vats for Tanners, Platers, Chemical Works, etc.
- † Bolts and nuts and lag screws (in condensers for Oil and Chemical trade).
- †* Pickling crates and frames for Rolling Mills.
- † Pickling Pins for Rolling Mills.
- † Tie Rods—Pickling Tanks for Rolling Mills.
- ††* Pump liners and rods.
- *† Valves and valve trim for use with chemicals.

Dyehouse Equipment

(Acid and Alkaline Solutions)

- ††* Dyeing and bleaching machinery—parts that come in contact with chemicals.
- *†† Drying machines.
- *† Pump liners.
- † Pump rods.
- * Castings
- † Rods w Wire
- † Sheets or Strips.

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Mining Equipment

(Alkaline Water, Etc.)

- †*† Mining machinery and equipment, mine screens, coal chutes, etc.
- †* Pump liners.
- † Pump rods.

Automobiles

(Exposure to Weather)

- † Ball bearings.
- †* Auto fittings and parts—brake release lever grips, handles, etc.

Dairy Equipment

(To Insure Easy Sterilizing)

- ††*w Dairy machinery—butter handling machines, milking machines, separators and pasteurizers, etc.

Packing Houses

(Salt Water)

- ††*w Equipment in general, of Packing Houses that comes in contact with brine and salt.
- †* Pump liners and rods.

Miscellaneous Uses

- † Storage battery casings
- † Meat slicing and grinding machines.
- * Golf club heads.
- †* Parts of submarine torpedoes and ordnance.
- † Valve stems for high-pressure fire service.
- * Handles for knotters used in the Textile trades.
- ††*w Machinery and equipment for use in the tropics.
- † Fountain pen parts.
- †*† Ink handling machines—bottle fillers, etc.
- *† Ornamental trim on Public Buildings.
- *† Mechanical conveyors and containers in furnaces for tempering and forging.
- *† Parts of equipment in Glass Factories that come in contact with hot glass.
- *† Incinerator and sewage handling machinery.
- w Wire netting and screens.
- † Burning points and racks for enamel ware makers.
- * Still plugs and parts for Burton stills (used in the production of gasolene).
- † Skylight frames and flashings for train sheds.
- ††† Laundry machine parts.
- ††† Refrigerating machinery and refrigerators.
- †† Knives, forks and spoons, novelties, etc.
- †† Bank vault and safe trim handles, wheels, etc.
- *† Artificial limbs.

Any information we may have on file regarding the above uses may be had on inquiry

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